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THE HOME PRODUCTION OF ONION SEED AND SETS.

BY

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U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., January 12, 1911.

SIR: I have the honor to transmit herewith a manuscript entitled "The Home Production of Onion Seed and Sets," by Mr. W. R. Beattie, Assistant Horticulturist, and to recommend that it be published as a Farmers' Bulletin.

The production of onion seed and sets is of considerable importance from both a truck-crop and farm standpoint. As the handling of these crops requires a knowledge of special methods of culture there is a constant demand for the information herein contained.

Respectfully,

WM. A. TAYLOR,
Acting Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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THE HOME PRODUCTION OF ONION SEED AND SETS.[1]

INTRODUCTION.

Many of the leading onion growers of the Northern States are now raising their own supplies of seed, for by so doing they can procure a better grade than is obtainable in the general market. During the early history of onion-seed growing in this country the crop was practically all produced in small plantings. Later the production of seed fell into the hands of a few large or speculative growers. During recent years there has been a tendency to return to former conditions.

Formerly the supply of onion seed came from farmers who selected seed bulbs of a uniform type year after year and in so doing established a definite strain; these bulbs were chosen from the entire crop of marketable onions, which permitted the selection of only those of the type desired for seed. In so doing the farmers were practicing selection, all bulbs not conforming to the desired type being discarded. In commercial onion-seed growing, where the bulbs are grown exclusively for seed purposes, it would not be profitable to discard all those that do not conform to the desired type.

It is customary for growers to select very carefully the few mother bulbs necessary to produce stock seed from which to grow their commercial crop of seed. In cases where commercial seed growers are short of bulbs for seed purposes, they frequently go into the market and purchase the best obtainable to make up the deficiency. Where a farmer is producing three or four thousand bushels of onions for the market from pedigree seed, it will be a comparatively easy matter for him to select two or three hundred bushels of extra fine bulbs of the type desired for seed. Onion seed produced in this

[1] For the culture of onions for the general market, see Farmers' Bulletin No. 354, entitled "Onion Culture," which will be sent free on application to the Secretary of Agriculture.

manner from selected bulbs and sold at $1.50 a pound will in the end be cheaper than seed at 40 cents a pound that has come from a miscellaneous lot of bulbs taken as they run, without selection.

Unfortunately, the home production of onion seed is now more or less dependent upon the market price of onions the previous season. Many growers plant for seed only when they have failed to sell their crop, thus giving uncertainty and irregularity to the enterprise. There are a few farmers who plant a fairly uniform quantity of bulbs for seed each year, and who are making a decided success of the work.

Certain growers are better equipped than are others for the growing and handling of the seed, and thus are in position to supply seed for the entire community. It has been found that carefully grown seed planted in the same general locality in which it is produced will give better results than seed brought from a distance; this is especially true in northern localities, where the season of growth is short, as southern-grown seed requires a longer season for its maturity.

The production of onion sets has been confined to a few localities. Now, however, the industry is receiving more general attention. Sets may be produced under a reasonably wide range of conditions, but in order to be successful it is essential that the grower should fully understand the principles and methods involved. The production of onion seed and sets is an important phase of the general onion industry, but owing to its more local nature it is treated separately.

HOME PRODUCTION OF ONION SEED.

SELECTION AND CARE OF BULBS FOR SEED.

The bulbs, or "mother bulbs," as they are commonly called, for the production of onion seed should be grown in the same manner as those intended for marketing, except that more care should be taken throughout. Some seed growers prefer to use 6 pounds of seed to an acre for the production of seed bulbs instead of 4 pounds, as ordinarily used in growing for market, in order that the bulbs may crowd and not become too large. The planting, culture, and harvesting of the bulbs are practically the same as for first-class marketable stock.

Onion-seed growing is a two-year process and two crops are constantly to be cared for. After growing the bulbs the first summer they must be stored over winter and replanted the following spring for the production of seed. Meantime the crop for the next year's planting must be coming on in order to have a crop of seed every year.

Onion seed can not be grown profitably in all parts of the country, for various reasons. Proper soil conditions are essential; also a climate that is free from extremes of temperature and rainfall. Cer-

tain localities in the Northeastern States near the ocean, around the Great Lakes, and again on the Pacific coast are especially adapted to the production of onion seed.

The first requisite for the growing of the best seed is a clear-cut ideal of the exact shape, form, color, and general characteristics sought in the variety being grown. The second requisite is the growing of seed from bulbs of that exact type for the greatest possible number of generations.

Two selections should be made, the first to include but a small number of the very finest and most ideal bulbs from which to produce the stock seed to be used the following year for the growing of the seed bulbs, and the second to include the bulbs from which to grow the supply of seed for the market. By keeping the very best stock separate and using the product for propagation the entire strain will be gradually improved. Bulbs a trifle below the ideal market size, or about 1½ to 2 inches in diameter, are the most profitable for seed production.

CARE OF BULBS DURING WINTER.

Bulbs that are to be used for seed production should be allowed to become thoroughly ripe in the field. After pulling they should be stored in crates under a roof where they will have plenty of ventilation and be protected from sun and rain. Before freezing weather begins the onions should be graded and removed to a house where both ventilation and temperature can be controlled.

The temperature of the storage house should at no time be so low as to cause the bulbs to become frosted. A temperature of 32° F. for a short period will do no harm, but should not be allowed to continue. If the bulbs become frosted, heated, or sweated in storage they will sprout before planting time and be greatly injured for seed purposes. In general, the storage conditions should be the same as for marketable onions.

SOILS ADAPTED TO THE GROWING OF ONION SEED.

Two types of soil may be used to advantage in growing onion seed. The soil upon which the bulbs are grown from seed should be quite rich and well supplied with organic matter and moisture. Good, rich, sandy loam is best adapted to the growing of the bulbs. For the production of seed from bulbs a soil that is well drained, fertile, and of a loamy nature is desirable. It is customary to grow the bulbs the first season on rich bottom land and to grow the seed the second season on well-drained upland. Soils containing an abundance of lime, such as are suited to the successful production of wheat, are adapted to onion-seed growing. The soil should be free from weed seeds and in a good state of tilth.

The bulbs for seed growing should not be set in a soil containing large quantities of fresh stable manure or green vegetable matter, but rather in a soil where some cultivated crop, such as corn, has been grown the previous season. Commercial fertilizers containing a small percentage of nitrogen, 6 to 8 per cent of available phosphoric acid, and 6 to 8 per cent of potash can be used to advantage at a rate not exceeding 1,000 pounds to the acre.

PREPARATION OF THE SOIL AND PLANTING.

In preparing the land for setting the bulbs apply the fertilizer and reduce the soil to a good state of tilth. Then mark off the land in rows about 2½ to 3½ feet apart by means of a one-horse plow, a

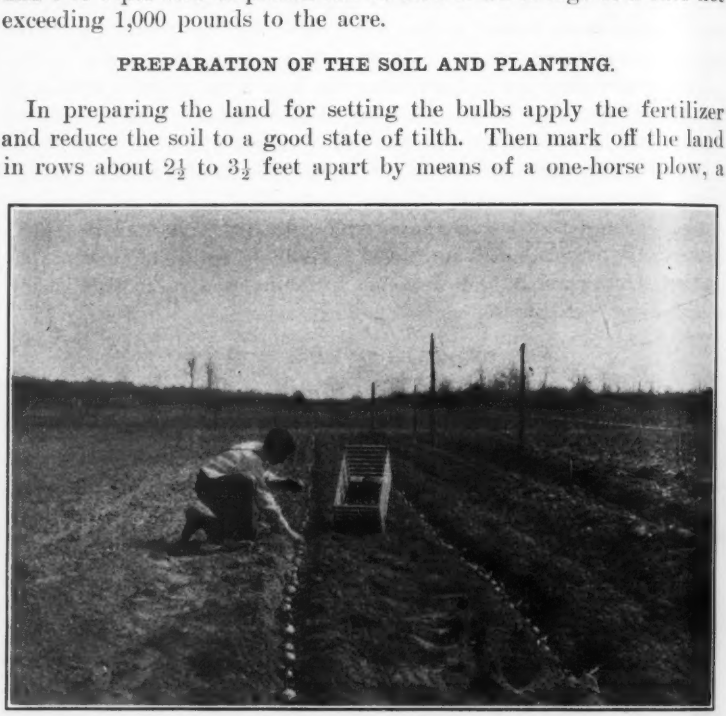

FIG. 1.—Method of setting out bulbs for seed production.

corn marker, or some tool that will leave a decided furrow in which to set the bulbs. In some sections the rows are placed as close as 2 feet, but this hinders cultivation.

The bulbs should be placed by hand (fig. 1), root downward, from 3 to 6 inches apart, center to center, in the furrow. The usual rule is to so set the bulbs that the distance between them will be about equal to the diameter of the bulbs. The quantity of bulbs that may be set on an acre will depend largely upon their size, but may be as high as 250 bushels. Where the seed is to be employed for growing sets and overgrown sets are used as "mother" bulbs the quantity required may be as low as 50 bushels to the acre. The

bulbs should be placed in the ground sufficiently deep to be entirely below the surface of the soil when covered. As growth proceeds, the soil should be drawn around the bulbs to form a support for the seed stalks.

CULTIVATION.

Shallow cultivation should be given throughout, the object being to keep the land free from weeds and the soil worked toward the plants. Very little handwork will be necessary except, perhaps, to go through after the seed heads have formed, remove the weeds, and draw the soil around the plants to hold the stalks erect and prevent the seed heads from blowing down and coming in contact with the soil.

FIG. 2.—Field of onion seed a short time before harvesting.

TIME AND MANNER OF GATHERING THE SEED.

The proper time to gather the seed is when the inside of the grain has reached the dough stage. Onion seed assumes its black color very early; in fact, before it has passed the watery stage and formed milk in the grain. This change of color is no indication of ripeness and very often deceives the inexperienced grower. The heads should be harvested just before the first-formed seed begins to shatter in handling.

Figure 2 shows a field of onions a short time before the seed is ripe. In harvesting, the heads are cut by hand, with 2 to 6 inches of the stem attached, and are placed in bags for transportation to the curing sheds.

CURING THE SEED HEADS.

Any building having a tight floor and in which a free circulation of air can be maintained will serve as a curing place for onion seed. Many growers employ buildings similar to those used for curing tobacco, with the alternate vertical siding boards hinged so that they can be thrown open during good weather. In localities where rains do not occur during the curing period the seed heads are frequently dried on sheets of canvas stretched over frames or spread upon the ground.

For curing the seed in houses, wire-bottomed racks or trays placed one above the other are generally employed. As the seed is stirred from time to time during the curing process considerable of it will be shattered and fall upon the tray below or finally upon the floor. The main essentials in the curing of onion seed are to spread the heads very thinly, not over two heads in depth, and to give free ventilation. Even at a depth of 3 inches in the trays it will be necessary to stir them very often, especially during damp weather.

THRASHING AND CLEANING THE SEED.

The date for gathering the seed depends upon the locality and climate, but as a rule this will be about midsummer or not later than August 15. The thrashing and cleaning of the seed are often deferred until quite late in the autumn, except where the curing is done in the open air. Where large quantities of seed are produced the thrashing is done with machines similar to regular grain thrashers, but when grown on a small scale the seed is removed by beating with a flail.

After the seed has been thrashed, there is still considerable danger of its heating or molding if left in too great bulk. The usual practice is to run it through a fanning mill to remove the dust and small particles of the heads or chaff that are broken up in thrashing. In former years the method of cleaning was to place the seed in a tank of water, the heavy seed settling to the bottom of the tank, while the chaff and lighter portions could be floated off. This process is no longer used to any great extent, owing to the improvement in cleaning machinery, and the danger of injuring the seed by the water. After the seed is fanned and most of the foreign matter removed, it should be spread thinly on the floor or canvas and stirred from time to time. About the only test that can be applied in order to detect moisture in the seed is that of feeling it with the hand, and anyone experi-

enced in the handling of seed will soon become expert at determining when it is safe to bag it ready for storage or shipment.

YIELD OF ONION SEED TO AN ACRE.

The quantity of onion seed that can be grown on an acre depends on several conditions. In the first place this will be determined largely by the size of the bulbs that are planted. In the onion-set districts, where the seed with which to produce the sets is locally grown from overgrown sets, the quantity of seed is generally from 10 to 12 pounds to the bushel of bulbs planted. This seed, however, is not suitable for the production of standard market onions, and can be used for set growing only. In the production of seed from standard mother bulbs the yield is generally from 3 to 4 pounds of seed for every bushel of bulbs planted. This has been much higher in many cases, but 3½ pounds is generally considered satisfactory. The yield of seed as a rule will be about 400 pounds to the acre, although as high as 800 or even 1,000 pounds have been secured.

The price per pound paid for the seed varies according to the quality, variety, and market demands. For first-class high-grade seed from specially selected bulbs of desirable types the growers frequently receive as much as $1.25 a pound, but for the general crop produced from bulbs not specially selected, which must be sold in competition with the great mass of seed produced by large growers, the price is generally not more than 40 or 50 cents a pound.

When the cost of growing the bulbs, together with the preparation of the land, the keeping of the bulbs over winter, the necessity of handling them a large number of times, and the occupying of the land for two seasons, is considered, it will be readily seen there is not a great profit in growing onion seed. However, there are quite a number of farmers who each year plant 2 or 3 acres to bulbs for seed, and have for sale anywhere from 1,000 to 1,500 pounds of very choice seed. In many cases this represents the money crop of the farm. The extent to which this enterprise could be conducted with profit is doubtless limited, but the demand for high-grade seed of a distinct type is increasing each year. Anyone contemplating the growing of onion seed should carefully study local conditions, and then operate in a small way until the necessary practices are understood.

PRODUCTION OF SEED FOR ONION-SET GROWING.

Frequently the seed for onion-set growing is produced from bulbs selected from the sets themselves; in other words, the bulbs or mother bulbs are the overgrown sets. Near Louisville, Ky., the onion-set growers select the oversized bulbs and store them over winter. In

the spring they send them to farmers in the hill country and have their supply of seed grown on bluegrass land which has not been heavily manured. In this way they are able to keep their onion seed free from disease and secure a higher vitality than if the seed were grown on the same land where the bulbs were produced.

Owing to the great quantity of seed employed in set growing it is desirable to secure it cheaply, and the bulbs selected from the sets, being small, will produce a larger quantity of seed per bushel from mother bulbs than when grown in the usual manner. The stock seed bulbs should, however, be well matured, small necked, uniform in size, and selected according to an ideal shape. Onion seed from undersized bulbs is not so desirable, even for set growing, as that from standard bulbs.

After a crop of onion seed has been gathered it is the usual custom to plow up the bulbs and devote the land to some other crop. If the old bulbs are allowed to remain in the soil through the winter, especially if given slight protection, they will produce a small crop of seed the second season. This practice is not recommended except under special conditions where the land is not valuable or where it is particularly desirable to secure an additional quantity of seed from the bulbs.

CARE OF ONION SEED.

The length of time that onion seed will retain its vitality depends largely upon maturity and climatic conditions. Well-matured seed will always keep better than poorly ripened and inferior seed. Under ordinary conditions onion seed loses its vitality very rapidly after the second year, especially if stored in a damp climate. It will often pay to ship the seed to a dry climate for storage.

PRODUCTION OF ONION SETS.

CLIMATE AND SOILS ADAPTED TO ONION-SET GROWING.

The term "set," as applied to the onion, indicates a small, undersized bulb which, when replanted in the ground, will produce a large onion. This method of producing onions is perhaps the oldest and now the most universally employed for the growing of small areas of onions in the garden and where an early crop is desired. The common method of producing sets is to plant a large quantity of seed on a small area of rather rich land and thus procure a great number of bulbs that are undersized, owing to crowding and lack of plant food. The greater number of these bulbs do not attain sufficient size or maturity to produce seed the following season and are really plants in which the process of growth has been arrested.

In the United States the onion-set industry is largely confined to a few areas. The crop is extensively grown near Louisville, Ky.,

Chillicothe, Ohio, and Chicago, Ill., in the Platte River Valley of Nebraska, in southwestern New Jersey, and in southern California. The entire area devoted to this enterprise in these localities is estimated at from 2,500 to 3,000 acres. The yield to the acre varies with the locality, but will average about 300 bushels. The market for onion sets is found throughout the entire country, the greater portion being disposed of in small quantities.

The climatic conditions governing the production of onion sets are practically the same as those for standard onions, although it is not necessary to plant quite so early in the spring. Onion sets can undoubtedly be grown in any part of the Northern States where suitable soil conditions can be obtained. The soil adapted to onion-set culture is as a rule about the same as that required for the growing of large onions, except that the land should not be so rich.

In the Louisville district the soil is a clay loam, containing plenty of lime. This soil, by the use of fertilizer, will yield 250 to 350 bushels of mature unions and will produce an equal quantity of sets, but the fertilizer requirements for the latter are not so great. This land is underlain at a depth varying from 18 inches to 10 or 12 feet by limestone, and is a natural bluegrass soil, retentive of moisture, and comparatively free from weeds.

In the vicinity of Chillicothe, Ohio, the soil is a river-bottom loam, being principally the washings from the hills. This soil contains occasional small beds of gravel, but owing to its silty nature it is retentive of moisture and easily cultivated.

In the Chicago area we find a variation in soil texture. In the vicinity of South Chicago, the area devoted to onion-set growing was formerly a sewage-disposal farm and is laid off in regular level beds. This soil is of a sandy, loamy nature and is very similar to the river-bottom lands at Chillicothe. Northwest of Chicago the soil is a more gravelly loam, although in some places it is of a river-bottom or silty nature.

In southwestern New Jersey the soil is a sandy loam, not unlike the Norfolk sandy loam, although it contains more or less gravel, and in places the clay approaches the surface.

It will be seen that onion sets can be grown on any land that is adapted to general truck crops, the main essential being freedom from weeds and a reasonably high state of tillage.

PREPARATION OF THE SOIL.

In preparing the land for onion-set growing the work should be performed in practically the same manner as for regular crops of onions. The plowing need be only moderately deep, but the soil must be brought to a smooth, fine surface, suitable for the proper sowing

of the seed by means of hand drills. The tools generally employed for this purpose are the plow, disk harrow, roller, smoothing harrow, and sometimes a pull or drag made of scantlings or planks. A harrow of the type shown in figure 3 is adapted to the final preparation before planting.

On some land onion sets have been grown continuously year after year without any appreciably injurious results. In other localities it has been found necessary to adopt a crop-rotation system, and this is advisable wherever the quantity of available land is sufficient. A rotation including corn, Irish potatoes, onion sets, and clover will be found quite satisfactory.

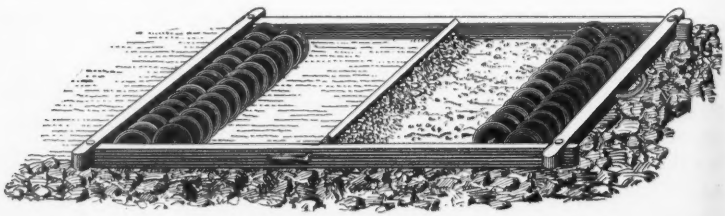

FIG. 3.—Harrow for leveling soil for planting seed.

FERTILIZERS.

In preparing the land for growing onion sets large quantities of barnyard manure should not be applied immediately before planting. If barnyard manure is to be employed it should be used the previous season on some other crop in order that it may become fully incorporated with the soil and in a measure subdued. Commercial fertilizers may be employed profitably in moderate quantities, say 600 to 1,200 pounds to the acre, and should be broadcasted at the time of fitting the land. This fertilizer should contain about 4 or 5 per cent of nitrogen, 6 or 8 per cent of available phosphoric acid, and 8 or 10 per cent of potash.

SOWING THE SEED.

As the essential feature of growing onion sets is the crowding together of the plants in the rows, a large quantity of seed is required to plant an acre. The quantity of seed required varies with the different localities. In the vicinity of Louisville, Ky., from 55 to 60 pounds to the acre are sown; Chillicothe, Ohio, 40 to 50 pounds; Chicago, 55 to 120 pounds; while in New Jersey as low as 25 pounds to the acre are used.

The drills employed for seeding are, as a rule, the hand seeders usually found upon the market used for sowing seed of all small

truck crops. In some localities, however, special seeders have been designed in order to distribute the seed in a particular manner. Near Chillicothe, Ohio, many of the growers employ a drill having five small teeth similar to the shoes of an ordinary grain drill, but on a very small scale. (See fig. 4.)

These seeders distribute the seed in five little drills about an inch apart, making a broad belt of five rows. Another method is to place a funnel-shaped spreader on the under part of the drill, which scatters the seed over an area of 3 or 4 inches in width.

DISTANCES TO PLANT AND QUANTITY OF SEED REQUIRED.

The distance between the rows ranges from 7 to 14 inches, but varies with the method of sowing. The larger yields are obtained

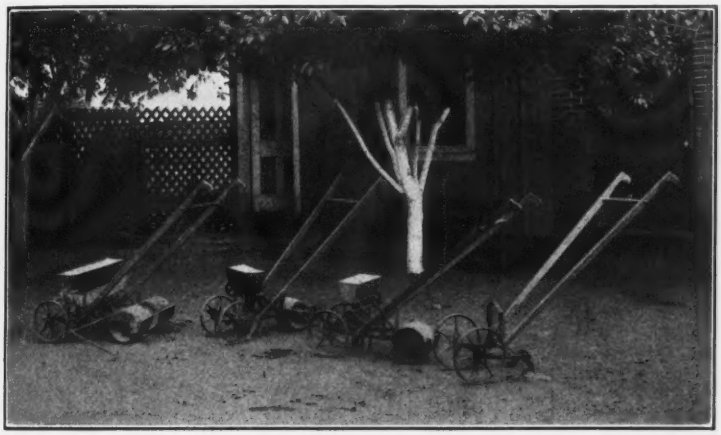

FIG. 4.—Special tools for planting and cultivating onion sets.

by sowing in single drills about 9 inches between the rows and using 65 to 85 pounds of seed to the acre. The majority of growers endeavor to sow their onion seed as early as the land can be put in first-class condition. Formerly the seeds for sets were not sown until late in the season, but it has been found that larger yields of sets can be obtained and that the sets will ripen better if the seed is sown early.

The New Jersey growers have found it more profitable to grow a sort of mixed crop, including all sizes from sets to marketable onions. A smaller quantity of seed is employed per acre, but, on the other hand, the method of growing is somewhat different, and a larger percentage of overgrown bulbs is secured. Those that are below standard size are sold as "boilers" or "stewers," "picklers," and "sets."

By using about 25 pounds of first-class seed to the acre and planting in rows 24 inches apart these growers are enabled to employ horse culture, and succeed in growing about 300 bushels of all sizes to the acre. This method of planting does not greatly decrease the yield and at the same time reduces the cost of cultivation.

CULTIVATION.

As a rule onion seed will germinate and the plants appear above ground so that the rows can be followed within six or eight days after planting. It is desirable that the soil should be stirred frequently and that the weeds should never be given an opportunity to gain a foothold. The onion sets should be cultivated at least once every week during their growing period, and oftener if rains occur.

The tools employed are for the most part of the wheel-hoe type, of which there are a number of forms. These tools are provided with numerous attachments for cutting close to the plants, for throwing the soil away from the rows, and for leveling and working it back around them. One or two of the Chicago growers have adopted a special wheel hoe of their own design, using the front wheel of a bicycle and a pair of light-weight plow handles for the frame, to which the various types of sweeps and shovels are attached. In New Jersey horse tools are employed almost exclusively, the 14 or 15 tooth harrow-type cultivator (fig. 5) being the favorite.

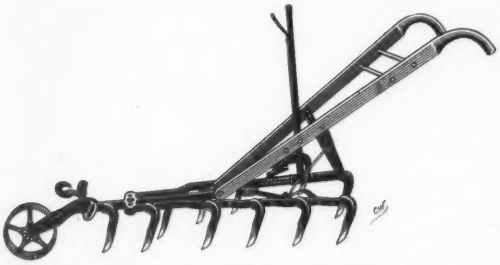

FIG. 5.—One-horse cultivator of the harrow type.

Hand weeding seems to be an essential in all localities, although this laborious process can be eliminated to some extent by proper wheel-hoe and horse cultivation. The cost of hand weeding and care of the onion-set crop may be anywhere from $10 to $50 an acre for the season. The entire cost of the cultivation of an acre of onion sets during the season should not exceed $50, and this may be reduced 50 per cent if the land is in proper condition and the work is handled at the right time. Hand weeding in most cases will be necessary twice during the growth of the crop. During rainy seasons it is often found impossible to keep certain areas clean, and when the weeds once become well established there is very little hope of saving the crop. When the sets have attained considerable growth the tops shade the ground and prevent, in a measure, the

growth of weeds. After this stage has been reached very little attention will be required. In fact, the stirring of the soil should

FIG. 6.—Hand weeding an onion-set field during early summer.

FIG. 7.—Harvesting onion sets near Louisville, Ky.

cease before the sets show any tendency to ripen. Figure 6 will give some idea of the appearance of an onion-set field at the period of its maximum development.

HARVESTING AND CURING.

The time for harvesting is just when the sets begin to ripen. This generally occurs about July 4 in southern localities, and July 20

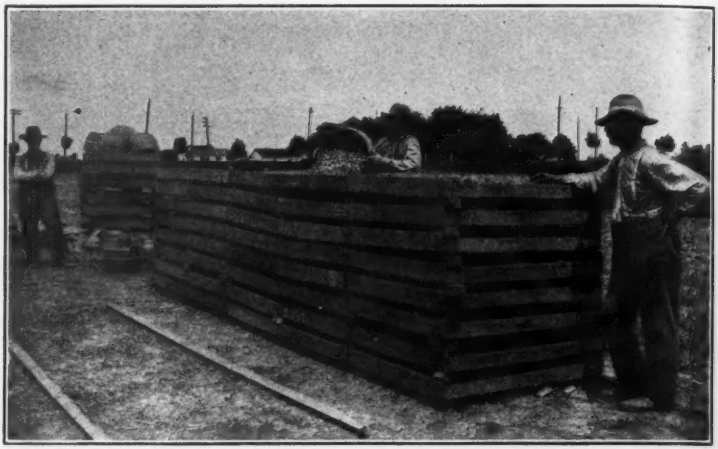

FIG. 8.—Onion sets drying on trays piled in a field.

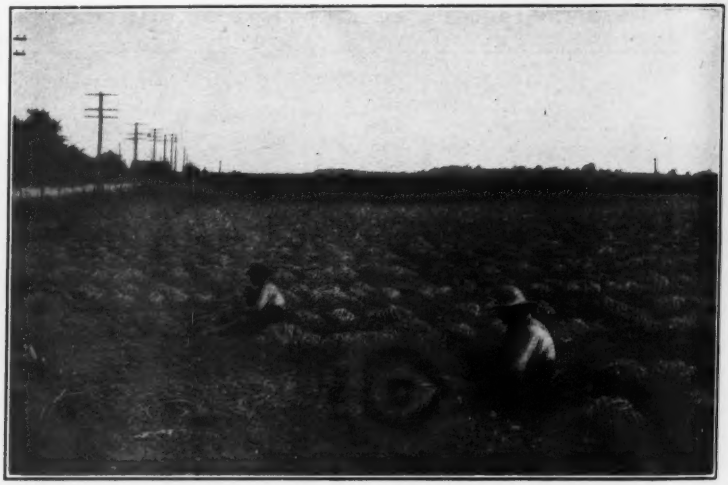

FIG. 9.—"Stacking" onion sets to cure in a field.

near Chicago, or from 90 to 110 days from the date of sowing the seed. The methods of harvesting are different in the several localities. Near Louisville, Ky., the sets are allowed to become quite ripe before harvesting.

At harvest time, the sets are loosened from the soil by means of a cutter attached to a wheel hoe or with broad forks having 10 or 12 tines. They are then pulled by hand, as shown in figure 7, the tops twisted off by hand, and the bulbs sifted and placed upon trays to dry. These trays are piled one upon another in the field (fig. 8) with a space of 3 or 4 inches between and a temporary roof placed over them. They are allowed to remain upon these trays until quite dry and are again screened and removed to the storehouse.

Near Chillicothe, Ohio, the sets are pulled while yet quite green and stacked in the field in long narrow ridges (figs. 9 and 10), the bulbs being placed underneath so that the tops will protect them from sunlight and rain. After remaining in these ridges about two weeks,

FIG. 10.—Onion sets curing in "stacks."

the tops are twisted off and the bulbs placed upon screens to dry. From the screens they are hauled to the warehouse where the fanning and cleaning take place.

Near Chicago, the practice of pulling is very similar to that in the vicinity of Louisville, the tops being twisted off as the sets are removed from the soil. In New Jersey the sets are allowed to become fully ripe before being removed from the soil and are harvested and cured together with the larger bulbs, after which they are separated by screening and fanning.

After pulling it is essential that the sets be subjected to a drying process; during this process they require plenty of ventilation. This

can be most easily secured by spreading the sets on trays, commonly called crates, that are provided with corner pieces extending 4 or 5 inches above the sides of the trays. As a rule these trays are constructed with 3-inch sides, about 5 feet square, with slat or wire bottoms, and hold about 3 bushels of onion sets. When the trays are piled one upon another the corner pieces provide an air space above each tray, thus securing the best possible ventilation. In the absence of corner pieces blocks of wood or broken bricks are employed, as shown in figure 8.

STORING ONION SETS.

The method of storage is essentially the same in all localities, the tray previously described being most commonly used (fig. 11). When

FIG. 11.—Onion sets stored on trays in a warehouse.

the sets have become sufficiently dry some growers transfer them to 1-bushel crates, in which they are shipped. Onion sets are stored under conditions similar to those required for large onions, the essentials being plenty of ventilation, dryness, and a comparatively low temperature. Slight freezing will not destroy them, provided they are not disturbed while frozen. However, freezing is always injurious and has a tendency to cause them to sprout earlier in the spring. If a uniform temperature 2 or 3 degrees above freezing can be maintained it is more satisfactory than too frequent variation.

Some growers employ a form of open shed as a temporary storage place for the sets during the autumn months or until cold weather

begins. A few growers store their crop until late winter and sell direct to seedsmen and dealers, but the majority turn their sets over to warehousemen for storage and disposal. Throughout the storage period the sets should be handled as little as possible and should be kept spread out thinly, so there will be no chance of heating. Onions in storage are constantly giving off more or less moisture and are liable to become damp and sprout if stored in too great bulk.

In preparing the sets for market they are first passed through a fanning mill which removes all loose skins, earth, or shriveled bulbs, and then over a screen which removes any bulbs that are too large for the market demands. After this they are shipped in 1-bushel crates, burlap bags, or barrels.

The crate is perhaps most desirable as a shipping package, as it protects the bulbs and allows a free circulation of the air. When shipped in bags, the sets are liable to become injured, except where they are handled in carload lots. Tight barrels are objectionable unless the sets are thoroughly cured, as there is liability to heat in the center.

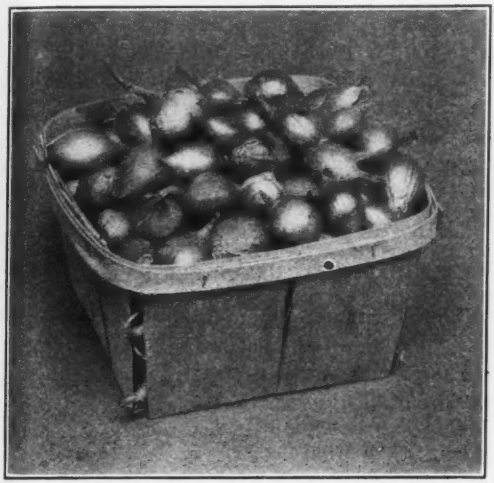

FIG. 12.—A quart of almost ideal onion sets.

PROPER SIZE OF ONION SETS.

The ideal onion set is almost globular in shape and a trifle less than half an inch in diameter. Figure 12 shows a quart of first-class onion sets. The color should be bright and the surface free from smut or spots of any kind. The term "pickler" is applied to the onion just above sets in size, or, in other words, one-half to three-fourths of an inch in diameter. The term "boiler," or "stewer," is applied to the size next larger than picklers, which are too small for sale as standard onions, or from three-fourths of an inch to 1¼ inches in diameter.

Another type of bulblet sometimes sold for propagation is that of the "top" or "tree" onion. These bulblets are formed on the top of a stalk similar to a flower stalk, and if planted will produce a

fair-sized bulb. If the bulbs are allowed to remain in the soil they will throw up stalks the following season and produce bulblets for further planting. This variety is extensively used for the production of young onions which are peeled, bunched, and marketed during the early spring. The bulblets are planted closely, either in beds or in rows, during the late autumn, and the young onions will be ready for use early in the spring. In cold climates slight protection will be required in order to carry the planted bulbs safely through the winter.

VARIETIES OF ONIONS USED FOR SETS.

Seed of almost any variety of onion may be used for the production of sets, but a greater demand exists for the distinctly yellow, white, and red colors. In the trade the sets are recognized by their color rather than by actual varietal names. The demand for the yellow and the white sets is greater than for the red, and those of the globular type are generally preferred.

Onion sets are sometimes grown from left-over seed, in which case a large number of varieties may be included. In the principal set-growing districts, where the seed has been locally grown for many years, the varieties are more or less distinct from those of seedsmen's catalogues.

ENEMIES OF THE ONION.

FUNGOUS DISEASES AND INSECT PESTS.

The onion crop of the United States is by no means free from both disease and insect enemies. Some of the enemies of the onion may be controlled without much difficulty, while others, if once established, can not be eradicated by any means known at present.

Onion Smut.

The following paragraphs are extracted from a recent bulletin issued by the Ohio Agricultural Experiment Station:

Onion smut (*Urocystis cepulae* Frost), unlike the other smuts with which we have to do, propagates itself almost indefinitely in the soil when this once becomes infested. Whenever a new crop of onions is grown from seed in this infested soil the smut attacks the young seedling onions, in whole or in part, and a very considerable loss results therefrom. If, however, onion sets are put in such soil or seedling onions that have been started under glass in healthy soil are transplanted to smut-infected soil, the smut fungus can not attack them. The explanation seems to be that the smut threads are only able to penetrate the leaves of the young, tender seedlings. Flowers of sulphur have been used to sow with the seed in infested soil, and this remedy has given but slightly inferior results to any other yet tried.

The best method has proved to be that of formaldehyde drip with seeder. The formaldehyde solution is made at the rate of 1 pound of 40 per cent formaldehyde to 25 to 33 gallons of water. This is applied with drip attachment on seed drill at rate of 125 to 150 gallons per acre for field onions. The same results can be obtained in open furrows by applying solution with sprinkler after seeds are scattered until well moistened. This formalin treatment insures the disinfection of a layer of soil near the seed and permits the germination and the early growth of the seedling onion past infection stage before the smut fungus can again occupy this soil. The gains from this treatment, both in the onion-set work and in field onions are very large, amounting to 100 to 200 per cent increase.[1]

The Maggot.

The onion maggot is often very destructive in fields that are just planted. This insect works at the roots of the young seedlings and is difficult to control.

The following methods of control have been suggested:

Carbolic-acid emulsion.—For all three forms of root maggots which we are considering, a carbolized form of kerosene emulsion is effective. This is prepared by adding to 1 pound of soap boiled in 1 gallon of water one-half gallon of crude carbolic acid and diluting the whole with from 35 to 50 parts of water. This mixture is applied about the stalks of the plants affected. It is best to use it a day or two after the plants are up or are transplanted, and repeat every week or 10 days until about the third week in May in the North. Farther south these applications must be made earlier in the season.

The use of mineral fertilizers.—Mineral fertilizers are useful as deterrents, particularly when employed just before or after a shower has thoroughly wet the ground. The principal fertilizers for this purpose are kainit, nitrate of soda, and sulphate or chlorid of potash. They may be used as top dressings before planting, or, if not employed until afterwards, they should be applied as nearly as possible to the roots, the earth being turned away from the plants for this purpose. These fertilizers possess the advantage of acting also as a stimulant to plant growth, thereby facilitating recuperation from root-maggot attack.

Danger from use of organic fertilizers.—Stable manure and organic fertilizers are apt to induce infestation, since the species under consideration is well known to develop in excrement and other decomposing material. Numerous instances of this have come to the writer's knowledge during recent years. It is advisable, therefore, to avoid the use of manure, rotted leaves, or other organic fertilizers, and to avoid planting in fields in which there have been infested or diseased plants.[2]

The Thrips.

The onion thrips belongs to the class of sucking insects, attacking the leaves and causing them first to assume a dull-gray or dirty appearance and afterwards to turn brown and die. This insect has proved very destructive, especially throughout the Southern States,

[1] Ohio Agricultural Experiment Station Bulletin No. 214.

[2] Circular No. 63, Bureau of Entomology, U. S. Dept. of Agriculture.

and is now becoming quite a serious pest in the Bermuda-onion district of Texas. It is noticeable that insects of this character generally attack crops that are grown upon poor soils, that are late planted, and where the cultivation is neglected.

The remedies to be employed for the onion thrips are varied. Kerosene emulsion is of less value than for many other sucking insects; whale-oil soap is one of the standard remedies, and some of the tobacco or nicotine preparations have recently been found useful.

CONCLUSIONS.

There is nothing difficult in the production of either onion sets or seed and one or both may be undertaken as a side issue with other lines of farming. The work of caring for the crops may be done largely by women and children where it is desirable to provide work of this nature for them.

No large profit can be obtained from the production of either onion seed or sets, and the greater profits are obtainable from comparatively small plantings. On a considerable portion of the land devoted to onion-set raising the yield is less than 300 bushels to the acre. Allowing for the cost of seed, fertilizers, cultivation, harvesting, and handling, the net returns are not large, especially when sets bring only 50 or 60 cents a bushel.

The method of growing white onion sets followed by the New Jersey growers seems to be the most profitable, as the sets are simply a by-product of the onion crop, the main object being to secure a large yield of small, white onions, known as "picklers," which bring a high price in most of our markets.

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THE HOME PRODUCTION OF ONION SEED AND SETS

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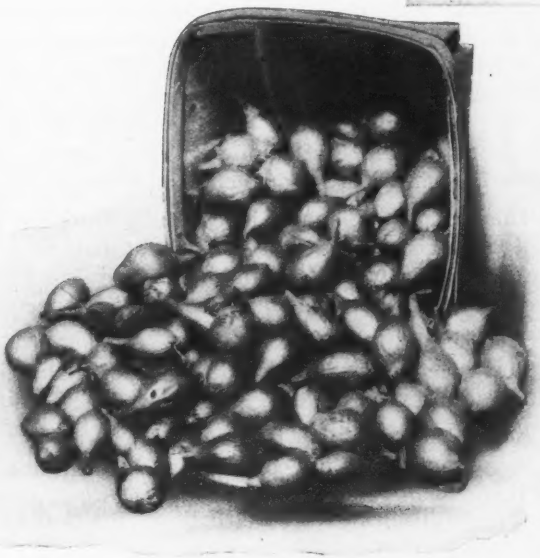
W. R. BEATTIE
Assistant Horticulturist



FARMERS' BULLETIN 434 [Rev.] Feb. 1918

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Rev.ed. follows

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MOST of the onion seed used in this country is produced by specialists. However, by growing his own seed the onion grower can secure strains better adapted to his particular conditions than by using seed bought on the general market. The grower can select a few bushels of mother bulbs from his entire crop, thus enabling him to save seed from choice specimens, while the commercial seed grower uses almost the entire crop for seed production.

The mother bulbs must be carefully stored so they will go through the winter without deterioration. Unless the grower has suitable storage it is best to secure seed from some one who has all the necessary facilities.

It is often advisable for a grower who has suitable facilities to produce seed for himself and his neighbors.

Some sections of the country are not well adapted to the growing of onion seed, owing to soil and climatic conditions. In these sections it is best to buy the seed from reputable growers.

The production of onion sets is not so difficult as the production of seed, as sets are grown in very much the same way as onions for market, except that a much larger amount of seed is required.

This bulletin gives directions for the growing of both seed and sets, with special reference to the farmer rather than the seed grower.

B. P. I.–645.

THE HOME PRODUCTION OF ONION SEED AND SETS.[1]

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MANY of the leading onion growers of the Northern States are raising their own supplies of seed, and by so doing they procure a better grade than is obtainable in the general market. During the early history of onion-seed growing in this country the crop was practically all produced in small plantings. Later, the production of seed fell into the hands of a few large, speculative growers. During recent years there has been a tendency to return to former conditions.

Formerly the supply of onion seed came from farmers who selected seed bulbs of a uniform type year after year and in so doing established a definite strain; these bulbs were chosen from the entire crop of marketable onions, which permitted the selection of enough bulbs of the type desired for seed. In so doing the farmers were practicing selection, all bulbs not conforming to the desired type being discarded. In commercial onion-seed growing, where the bulbs are grown exclusively for seed purposes, it would not be profitable to discard all those that do not conform to the desired type.

It is customary for growers to select very carefully the few mother bulbs necessary to produce stock seed from which to grow their commercial crop of seed. In cases where commercial seed growers

[1] For the culture of onions for the general market, see Farmers' Bulletin No. 354, entitled "Onion Culture," which will be sent free on application to the Secretary of Agriculture.

are short of bulbs for seed purposes, they frequently go into the market and purchase the best obtainable to make up the deficiency. Where a farmer is producing three or four thousand bushels of onions for the market from pedigree seed, it will be a comparatively easy matter for him to select from that quantity two or three hundred bushels of extra fine bulbs of the type desired for seed. Onion seed produced in this manner from selected bulbs and costing $1.50 a pound will in the end be cheaper than seed at 40 cents a pound that has come from a miscellaneous lot of bulbs taken as they run, without selection.

Unfortunately, the home production of onion seed is now more or less dependent upon the market price of onions the previous season. Many growers plant for seed only when they have failed to sell their crop, thus giving uncertainty and irregularity to the enterprise. There are a few farmers who plant a fairly uniform quantity of bulbs for seed each year, and who are making a decided success of the work.

Certain growers are better equipped than are others for the growing and handling of the seed, and thus are in position to supply seed for the entire community. It has been found htat carefully grown seed planted in the same general locality in which it is produced will give better results than seed brought from a distance; this is especially true in northern localities, where the season of growth is short, as southern-grown seed requires a longer season for its maturity.

The production of onion sets has been confined to a few localities. Now, however, the industry is receiving more general attention. Sets may be produced under a reasonably wide range of conditions, but in order to be successful it is essential that the grower should fully understand the principles and methods involved. The production of onion seed and sets is an important phase of the general onion industry, but owing to its more local nature it is treated separately.

HOME PRODUCTION OF ONION SEED.

SELECTION AND CARE OF BULBS FOR SEED.

The bulbs, or "mother bulbs," as they are commonly called, for the production of onion seed should be grown in the same manner as those intended for marketing, except that more care should be taken throughout. Some seed growers prefer to use 6 pounds of seed to an acre for the production of seed bulbs instead of 4 pounds, as ordinarily used in growing for market, in order that the bulbs may crowd and not become too large. The planting, culture, and harvesting of the bulbs are practically the same as for first-class marketable stock.

Onion-seed growing is a two-year process and two crops are constantly to be cared for. After growing the bulbs the first summer they must be stored over winter and replanted the following spring

for the production of seed. Meantime the crop for the next year's planting must be coming on in order to have a crop of seed every year.

Onion seed can not be grown profitably in all parts of the country, for various reasons. Proper soil conditions are essential; also a climate that is free from extremes of temperature and rainfall. Certain localities in the Northeastern States near the ocean, around the Great Lakes, and again on the Pacific coast are especially adapted to the production of onion seed.

The first requisite for the growing of the best seed is a clear-cut ideal of the exact shape, form, color, and general characteristics sought in the variety being grown. The second requisite is the growing of seed from bulbs of that exact type for the greatest possible number of generations.

Two selections should be made, the first to include but a small number of the very finest and most ideal bulbs from which to produce the stock seed to be used the following year for the growing of the seed bulbs, and the second to include the bulbs from which to grow the supply of seed for the market. By keeping the very best stock separate and using the product for propagation, the entire strain will be gradually improved. Bulbs a trifle below the ideal market size, or about 1½ to 2 inches in diameter, are the most profitable for seed production.

CARE OF BULBS DURING WINTER.

Bulbs that are to be used for seed production should be allowed to become thoroughly ripe in the field. After pulling they should be stored in crates under a roof where they will have plenty of ventilation and be protected from sun and rain. Before freezing weather begins the onions should be graded and removed to a house where both ventilation and temperature can be controlled.

The temperature of the storage house should at no time be so low as to cause the bulbs to become frosted. A temperature of 32° F. for a short period will do no harm, but should not be allowed to continue. If the bulbs become frosted, heated, or sweated in storage they will sprout before planting time and be greatly injured for seed purposes. In general, the storage conditions should be the same as for marketable onions.

SOILS ADAPTED TO THE GROWING OF ONION SEED.

Two types of soil may be used to advantage in growing onion seed. The soil upon which the bulbs are grown from seed should be quite rich and well supplied with organic matter and moisture. Good, rich, sandy loam is best adapted to the growing of the bulbs.

For the production of seed from bulbs a soil that is well drained, fertile, and of a loamy nature is desirable. It is customary to grow the bulbs the first season on rich bottom land and to grow the seed the second season on well-drained upland. Soils containing an abundance of lime, such as are suited to the successful production of wheat, are adapted to onion-seed growing. The soil should be free from weed seeds and in a good state of tilth.

The bulbs for seed growing should not be set in a soil containing large quantities of fresh stable manure or green vegetable matter, but rather in a soil where some cultivated crop, such as corn, has been grown the previous season. Commercial fertilizers containing a small percentage of nitrogen, 6 to 8 per cent of available phosphoric acid, and 6 to 8 per cent of potash can be used to advantage at a rate not exceeding 1,000 pounds to the acre.

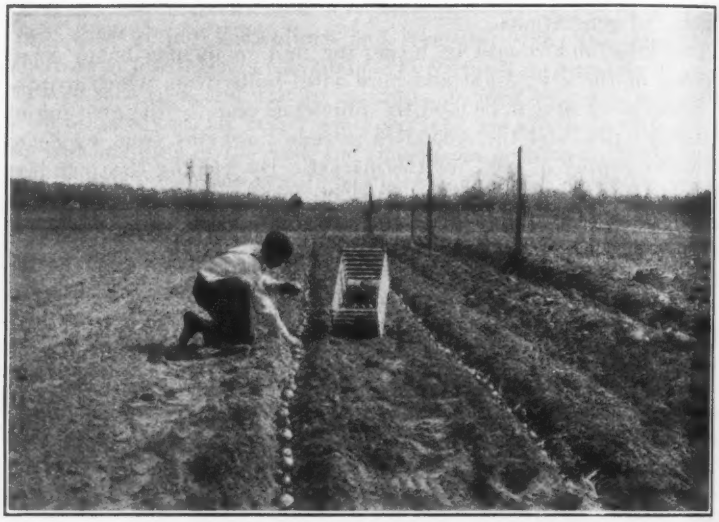

FIG. 1.—Method of setting out bulbs for seed production.

PREPARATION OF THE SOIL AND PLANTING.

In preparing the land for setting the bulbs, apply the fertilizer and reduce the soil to a good state of tilth. Then mark off the land in rows about 2½ to 3½ feet apart by means of a one-horse plow, a corn marker, or some tool that will leave a decided furrow in which to set the bulbs. In some sections the rows are placed as close as 2 feet, but this hinders cultivation.

The bulbs should be placed by hand (fig. 1), root downward, from 3 to 6 inches apart, center to center, in the furrow. The usual rule

is to so set the bulbs that the distance between them will be about equal to the diameter of the bulbs. The quantity of bulbs that may be set on an acre will depend largely upon their size, but may be as high as 250 bushels. Where the seed is to be employed for growing sets, and overgrown sets are used as "mother" bulbs, the quantity required may be as low as 50 bushels to the acre. The bulbs should be placed in the ground sufficiently deep to be entirely below the surface of the soil when covered. As growth proceeds, the soil should be drawn around the bulbs to form a support for the seed stalks.

CULTIVATION.

Shallow cultivation should be given throughout, the object being to keep the land free from weeds and the soil worked toward the plants. Very little handwork will be necessary, except, perhaps, to go through after the seed heads have formed, remove the weeds, and draw the soil around the plants to hold the stalks erect and prevent the seed heads from blowing down and coming in contact with the soil.

TIME AND MANNER OF GATHERING THE SEED.

The proper time to gather the seed is when the inside of the grain has reached the dough stage. Onion seed assumes its black color very early; in fact, before it has passed the watery stage and formed milk in the grain. This change of color is no indication of ripeness, and very often deceives the inexperienced grower. The heads should be harvested just before the first-formed seed begins to shatter in handling.

Figure 2 shows a field of onions a short time before the seed is ripe. In harvesting, the heads are cut by hand, with 2 to 6 inches of the stem attached, and are placed in bags for transportation to the curing sheds.

CURING THE SEED HEADS.

Any building having a tight floor and in which a free circulation of air can be maintained will serve as a curing place for onion seed. Many growers employ buildings similar to those used for curing tobacco, with the alternate vertical siding boards hinged so that they can be thrown open during good weather. In localities where rains do not occur during the curing period the seed heads are frequently dried on sheets of canvas stretched over frames or spread upon the ground.

For curing the seed in houses, wire-bottomed racks or trays placed one above the other are generally employed. As the seed is stirred from time to time during the curing process considerable of it will be

shattered and fall upon the tray below or finally upon the floor. The main essentials in the curing of onion seed are to spread the heads very thinly, not over two heads in depth, and to give free ventilation. Even at a depth of 3 inches in the trays it will be necessary to stir them very often, especially during damp weather.

THRASHING AND CLEANING THE SEED.

The date for gathering the seed depends upon the locality and climate, but as a rule this will be about midsummer or not later than August 15. The thrashing and cleaning of the seed are often deferred until quite late in the autumn, except where the curing is done in the

FIG. 2.—Field of onion seed a short time before harvesting.

open air. Where large quantities of seed are produced the thrashing is done with machines similar to regular grain thrashers, but when grown on a small scale the seed is removed by beating with a flail.

After the seed has been thrashed, there is still considerable danger of its heating or molding if left in too great bulk. The usual practice is to run it through a fanning mill to remove the dust and small particles of the heads or chaff that are broken up in thrashing. In former years the method of cleaning was to place the seed in a tank of water, the heavy seed settling to the bottom of the tank, while the chaff and lighter portions could be floated off. This process is no longer used to any great extent, owing to the improvement in cleaning

machinery, and the danger of injuring the seed by the water. After the seed is fanned and most of the foreign matter removed, it should be spread thinly on the floor or canvas and stirred from time to time. About the only test that can be applied in order to detect moisture in the seed is that of feeling it with the hand, and anyone experienced in the handling of seed will soon become expert at determining when it is safe to bag it ready for storage or shipment.

YIELD OF ONION SEED TO AN ACRE.

The quantity of onion seed that can be grown on an acre depends on several conditions. In the first place this will be determined largely by the size of the bulbs that are planted. In the onion-set districts, where the seed with which to produce the sets is locally grown from overgrown sets, the quantity of seed is generally from 10 to 12 pounds to the bushel of bulbs planted. This seed, however, is not suitable for the production of standard market onions, and can be used for set growing only. In the production of seed from standard mother bulbs the yield is generally from 3 to 4 pounds of seed for every bushel of bulbs planted. This has been much higher in many cases, but 3½ pounds is generally considered satisfactory. The yield of seed as a rule will be about 400 pounds to the acre, although as high as 800 or even 1,000 pounds have been secured.

The price per pound paid for the seed varies according to the quality, variety, and market demands. For first-class high-grade seed from specially selected bulbs of desirable types the growers frequently receive two or three times as much per pound as for the general crop produced from bulbs not specially selected, which must be sold in competition with the great mass of seed produced by large growers.

When the cost of growing the bulbs, together with the preparation of the land, the keeping of the bulbs over winter, the necessity of handling them a large number of times, and the occupying of the land for two seasons, is considered, it will be readily seen there is not a great profit in growing onion seed. However, there are quite a number of farmers who each year plant 2 or 3 acres to bulbs for seed, and have for sale anywhere from 1,000 to 1,500 pounds of very choice seed. In many cases this represents the money crop of the farm. The extent to which this enterprise could be conducted with profit is doubtless limited, but the demand for high-grade seed of a distinct type is increasing each year. Anyone contemplating the growing of onion seed should carefully study local conditions, and then operate in a small way until the necessary practices are understood.

PRODUCTION OF SEED FOR ONION-SET GROWING.

Frequently the seed for onion-set growing is produced from bulbs selected from the sets themselves; in other words, the bulbs or mother bulbs are the overgrown sets. Near Louisville, Ky., the onion-set growers select the oversized bulbs and store them over winter. In the spring they send them to farmers in the hill country and have their supply of seed grown on bluegrass land which has not been heavily manured. In this way they are able to keep their onion seed free from disease and secure a higher vitality than if the seed were grown on the same land where the bulbs were produced.

Owing to the great quantity of seed employed in set growing, it is desirable to secure it cheaply, and the bulbs selected from the sets, being small, will produce a larger quantity of seed per bushel from mother bulbs than when grown in the usual manner. The stock seed bulbs should, however, be well matured, small necked, uniform in size, and selected according to an ideal shape. Onion seed from undersized bulbs is not so desirable, even for set growing, as that from standard bulbs.

After a crop of onion seed has been gathered it is the usual custom to plow up the bulbs and devote the land to some other crop. If the old bulbs are allowed to remain in the soil through the winter, especially if given slight protection, they will produce a small crop of seed the second season. This practice is not recommended except under special conditions where the land is not valuable or where it is particularly desirable to secure an additional quantity of seed from the bulbs.

CARE OF ONION SEED.

The length of time that onion seed will retain its vitality depends largely upon maturity and climatic conditions. Well-matured seed will always keep better than poorly ripened and inferior seed. Under ordinary conditions onion seed loses its vitality very rapidly after the second year, especially if stored in a damp climate. It will often pay to ship the seed to a dry climate for storage.

PRODUCTION OF ONION SETS.

CLIMATE AND SOILS ADAPTED TO ONION-SET GROWING.

The term "set," as applied to the onion, indicates a small, undersized bulb which, when replanted in the ground, will produce a large onion. This method of producing onions is perhaps the oldest and now the most universally employed for the growing of small areas of onions in the garden and where an early crop is desired. The common method of producing sets is to plant a large quantity of seed on a small area of rather rich land and thus procure a great number of

bulbs that are undersized, owing to crowding and lack of plant food. The greater number of these bulbs do not attain sufficient size or maturity to produce seed the following season and are really plants in which the process of growth has been arrested.

In the United States the onion-set industry is largely confined to a few areas. The crop is extensively grown near Louisville, Ky., Chillicothe, Ohio, and Chicago, Ill., in the Platte River Valley of Nebraska, in southwestern New Jersey, and in southern California. The entire area devoted to this enterprise in these localities is estimated at from 2,500 to 3,000 acres. The yield to the acre varies with the locality, but will average about 300 bushels. The market for onion sets is found throughout the entire country, the greater portion being disposed of in small quantities.

The climatic conditions governing the production of onion sets are practically the same as those for standard onions, although it is not necessary to plant quite so early in the spring. Onion sets can undoubtedly be grown in any part of the Northern States where suitable soil conditions can be obtained. The soil adapted to onion-set culture is as a rule about the same as that required for the growing of large onions, except that the land should not be so rich.

In the Louisville district the soil is a clay loam, containing plenty of lime. This soil, by the use of fertilizer, will yield 250 to 350 bushels of mature onions and will produce an equal quantity of sets, but the fertilizer requirements for the latter are not so great. This land is underlain at a depth varying from 18 inches to 10 or 12 feet by limestone, and is a natural bluegrass soil, retentive of moisture, and comparatively free from weeds.

In the vicinity of Chillicothe, Ohio, the soil is a river-bottom loam, being principally the washings from the hills. This soil contains occasional small beds of gravel, but owing to its silty nature it is retentive of moisture and easily cultivated.

In the Chicago area we find a variation in soil texture. In the vicinity of South Chicago, the area devoted to onion-set growing was formerly a sewage-disposal farm and is laid off in regular level beds. This soil is of a sandy, loamy nature and is very similar to the river-bottom lands at Chillicothe. Northwest of Chicago the soil is a more gravelly loam, although in some places it is of a river-bottom or silty nature.

In southwestern New Jersey the soil is a sandy loam, not unlike the Norfolk sandy loam, although it contains more or less gravel, and in places the clay approaches the surface.

It will be seen that onion sets can be grown on any land that is adapted to general truck crops, the main essential being freedom from weeds and a reasonably high state of tillage.

PREPARATION OF THE SOIL.

In preparing the land for onion-set growing the work should be performed in practically the same manner as for regular crops of onions. The plowing need be only moderately deep, but the soil must be brought to a smooth, fine surface, suitable for the proper sowing of the seed by means of hand drills. The tools generally employed for this purpose are the plow, disk harrow, roller, smoothing harrow, and sometimes a pull or drag made of scantlings or planks. A harrow of the type shown in figure 3 is adapted to the final preparation before planting.

On some land onion sets have been grown continuously year after year without any appreciably injurious results. In other localities it has been found necessary to adopt a crop-rotation system, and this is advisable wherever the quantity of available land is sufficient. A rotation including corn, Irish potatoes, onion sets, and clover will be found quite satisfactory.

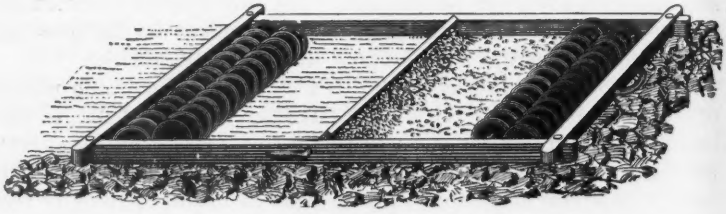

FIG. 3.—Harrow for leveling soil for planting seed.

FERTILIZERS.

In preparing the land for growing onion sets large quantities of barnyard manure should not be applied immediately before planting. If barnyard manure is to be employed, it should be used the previous season on some other crop in order that it may become fully incorporated with the soil and in a measure subdued. Commercial fertilizers may be employed profitably in moderate quantities, say 600 to 1,200 pounds to the acre, and should be broadcasted at the time of fitting the land. This fertilizer should contain about 4 or 5 per cent of nitrogen, 6 or 8 per cent of available phosphoric acid, and 8 or 10 per cent of potash.

SOWING THE SEED.

As the essential feature of growing onion sets is the crowding together of the plants in the rows, a large quantity of seed is required to plant an acre. The quantity of seed required varies with the different localities. In the vicinity of Louisville, Ky., from 55 to 60 pounds to the acre are sown; Chillicothe, Ohio, 40 to 50 pounds;

Chicago, 55 to 120 pounds; while in New Jersey as low as 25 pounds to the acre are used.

The drills employed for seeding are, as a rule, the hand seeders usually found upon the market, used for sowing the seed of all small truck crops. In some localities, however, special seeders have been designed in order to distribute the seed in a particular manner. Near Chillicothe, Ohio, many of the growers employ a drill having five small teeth similar to the shoes of an ordinary grain drill, but on a very small scale. (See fig. 4.)

These seeders distribute the seed in five little drills about an inch apart, making a broad belt of five rows. Another method is to place a funnel-shaped spreader on the under part of the drill, which scatters the seed over an area of 3 or 4 inches in width.

FIG. 4.—Special tools for planting and cultivating onion sets.

DISTANCES TO PLANT AND QUANTITY OF SEED REQUIRED.

The distance between the rows ranges from 7 to 14 inches, but varies with the method of sowing. The larger yields are obtained by sowing in single drills about 9 inches between the rows and using 65 to 85 pounds of seed to the acre. Most growers endeavor to sow their onion seed as early as the land can be put in first-class condition. Formerly the seeds for sets were not sown until late in the season, but it has been found that larger yields of sets can be obtained and that the sets will ripen better if the seed is sown early.

The New Jersey growers have found it more profitable to grow a sort of mixed crop, including all sizes from sets to marketable onions. A smaller quantity of seed is employed per acre, but, on the other hand, the method of growing is somewhat different, and a larger percentage of overgrown bulbs is secured. Those that are below stand-

ard size are sold as "boilers" or "stewers," "picklers," and "sets." By using about 25 pounds of first-class seed to the acre and planting in rows 24 inches apart these growers are enabled to employ horse culture and succeed in growing about 300 bushels of all sizes to the acre. This method of planting does not greatly decrease the yield and at the same time reduces the cost of cultivation.

CULTIVATION.

As a rule onion seed will germinate and the plants appear above ground so that the rows can be followed within six or eight days after planting. It is desirable that the soil should be stirred frequently and that the weeds should never be given an opportunity to gain a foothold. The onion sets should be cultivated at least once every week during their growing period, and oftener if rains occur.

The tools employed are for the most part of the wheel-hoe type, of which there are a number of forms. These tools are provided with numerous attachments for cutting close to the plants, for throwing the soil away from the rows, and for leveling and working it back around them. Some of the Chicago growers have adopted a special wheel hoe of their own design, using the front wheel of a bicycle and a pair of lightweight plow handles for the frame, to which the various types of sweeps and shovels are attached. In New Jersey horse tools are employed almost exclusively, the 14 or 15 tooth harrow-type cultivator (fig. 5) being the favorite.

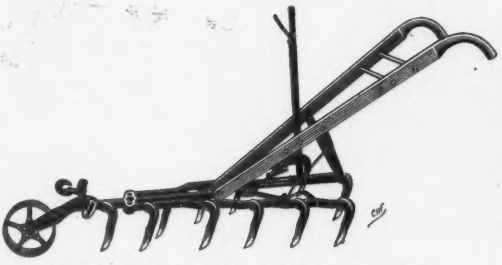

FIG. 5.—One-horse cultivator of the harrow type.

Hand weeding seems to be an essential in all localities, although this laborious process can be eliminated to some extent by proper wheel-hoe and horse cultivation. The cost of hand weeding and care of the onion-set crop may be anywhere from $10 to $50 an acre for the season. The entire cost of the cultivation of an acre of onion sets during the season should not exceed $50, and this may be reduced 50 per cent if the land is in proper condition and the work is handled at the right time. Hand weeding in most cases will be necessary twice during the growth of the crop. During rainy seasons it is often found impossible to keep certain areas clean, and when the weeds once become well established there is very little

hope of saving the crop. When the sets have attained considerable growth the tops shade the ground and prevent, in a measure, the growth of weeds. After this stage has been reached very little attention will be required. In fact, the stirring of the soil should cease before the sets show any tendency to ripen. Figure 6 will give some idea of the appearance of an onion-set field at the period of its maximum development.

HARVESTING AND CURING.

The time for harvesting is just when the sets begin to ripen. This generally occurs about July 4 in southern localities and July 20

FIG. 6.—Hand weeding an onion-set field during early summer.

near Chicago, or 90 to 110 days from the date of sowing the seed. The methods of harvesting are different in the several localities. Near Louisville, Ky., the sets are allowed to become quite ripe before harvesting.

At harvest time the sets are loosened from the soil by means of a cutter attached to a wheel hoe or with broad forks having 10 or 12 tines. They are then pulled by hand, as shown in figure 7, the tops twisted off by hand, and the bulbs sifted and placed upon trays to dry. These trays are piled one upon another in the field (fig. 8) with a space of 3 or 4 inches between and a temporary roof placed over them. They are allowed to remain upon these trays until quite dry and are again screened and removed to the storehouse.

FIG. 7.—Harvesting onion sets near Louisville, Ky.

Near Chillicothe, Ohio, the sets are pulled while yet quite green and stacked in the field in long narrow ridges (figs. 9 and 10), the bulbs being placed underneath so that the tops will protect them from sunlight and rain. After remaining in these ridges about two weeks, the tops are twisted off and the bulbs placed upon screens to dry. From the screens they are hauled to the warehouse where the fanning and cleaning take place.

Near Chicago the practice of pulling is very similar to that in the vicinity of Louisville, the tops being twisted off as the sets are removed from the soil. In New Jersey the sets are allowed to become fully ripe before being removed from the soil and are harvested and cured together with the larger bulbs, after which they are separated by fanning and screening.

After pulling, it is essential that the sets be subjected to a drying process; during this process they require plenty of ventilation. This can be most easily secured by spreading the sets on trays, commonly called crates, that are provided with corner pieces extending 4 or 5 inches above the sides of the trays. As a rule these trays are constructed with 3-inch sides, about 5 feet square, with slat or wire bottoms, and hold about 3 bushels of onion sets. When the trays are piled one upon another the corner pieces provide an air space above each tray, thus securing the best possible ventilation. In the absence of corner pieces blocks of wood or broken bricks are employed, as shown in figure 8.

STORING ONION SETS.

The method of storage is essentially the same in all localities, the tray previously described being most commonly used (fig. 11). When

the sets have become sufficiently dry some growers transfer them to the 1-bushel crates, in which they are shipped. Onion sets are stored under conditions similar to those required for large onions, the essentials being plenty of ventilation, dryness, and a comparatively low temperature. Slight freezing will not destroy them, provided they are not disturbed while frozen. However, freezing is always injurious and has a tendency to cause them to sprout earlier in the spring. If a uniform temperature 2 or 3 degrees above freezing can be maintained it is more satisfactory than too frequent variation.

Some growers employ a form of open shed as a temporary storage place for the sets during the autumn months or until cold weather begins. A few growers store their crop until late winter and sell direct to seedsmen and dealers, but the majority turn their sets over to warehousemen for storage and disposal. Throughout the storage period the sets should be handled as little as possible and should be kept spread out thinly, so there will be no chance of heating. Onions in storage are constantly giving off more or less moisture and are liable to become damp and sprout if stored in too great bulk.

In preparing the sets for market they are first passed through a fanning mill which removes all loose skins, earth, or shriveled bulbs, and then over a screen which removes any bulbs that are too large for the market demands. After this they are shipped in 1-bushel crates, burlap bags, or barrels.

The crate is perhaps most desirable as a shipping package, as it protects the bulbs and allows a free circulation of the air. When shipped in bags the sets are liable to become injured, except where

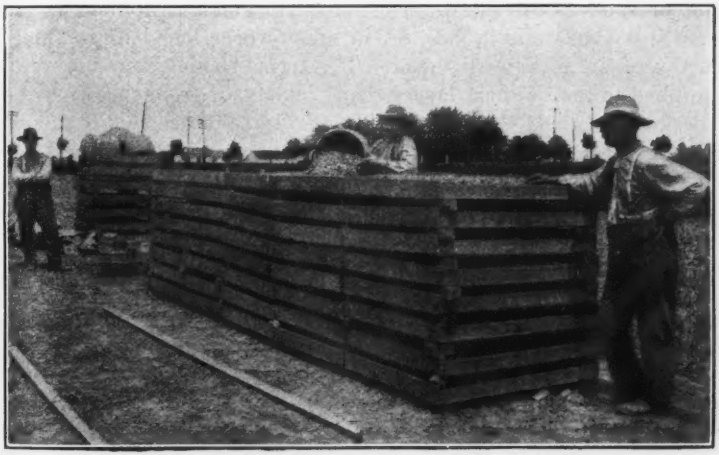

FIG. 8.—Onion sets drying on trays piled in a field.

FIG. 9.—"Stacking" onion sets to cure in a field.

they are handled in carload lots. Tight barrels are objectionable unless the sets are thoroughly cured, as there is liability to heat in the center.

PROPER SIZE OF ONION SETS.

The ideal onion set is almost globular in shape and a trifle less than half an inch in diameter. Figure 12 shows a quart of first-class onion sets. The color should be bright and the surface free from smut or spots of any kind. The term "pickler" is applied to the onion just above sets in size, or, in other words, one-half to three-fourths of an inch in diameter. The term "boiler," or "stewer," is applied to the size next larger than picklers, or from three-fourths of an inch to 1¼ inches in diameter, which are too small for sale as standard onions.

Another type of bulblet sometimes sold for propagation is that of the "top" or "tree" onion. These bulblets are formed on the top of a stalk similar to a flower stalk, and if planted will produce a fair-sized bulb. If the bulbs are allowed to remain in the soil they will throw up stalks the following season and produce bulblets for further planting. This variety is extensively used for the production of young onions which are peeled, bunched, and marketed during the early spring. The bulblets are planted closely, either in beds or in rows, during the late autumn, and the young onions will be ready for use early in the spring. In cold climates slight protection will be required in order to carry the planted bulbs safely through the winter.

VARIETIES OF ONIONS USED FOR SETS.

Seed of almost any variety of onion may be used for the production of sets, but a greater demand exists for the distinctly yellow, white, and red colors. In the trade the sets are recognized by their color rather than by actual varietal names. The demand for the yellow and the white sets is greater than for the red, and those of the globular type are generally preferred

Onion sets are sometimes grown from left-over seed, in which case a large number of varieties may be included. In the principal set-growing districts, where the seed has been locally grown for many years, the varieties are more or less distinct from those of seedsmen's catalogues.

ENEMIES OF THE ONION.

FUNGOUS DISEASES AND INSECT PESTS.

The onion crop of the United States is by no means free from both disease and insect enemies. Some of the enemies of the onion may be controlled without much difficulty, while others, if once established, can not be eradicated by any means known at present.

Onion Smut.

The following paragraphs are extracted from a bulletin issued by the Ohio Agricultural Experiment Station:

Onion smut (*Urocytis cepulae* Frost), unlike the other smuts with which we have to do, propagates itself almost indefinitely in the soil when this once be-

FIG. 10.—Onion sets curing in "stacks."

comes infested. Whenever a new crop of onions is grown from seed in this infested soil the smut attacks the young seedling onions, in whole or in part, and a very considerable loss results therefrom. If, however, onion sets are put in such soil or seedling onions that have been started under glass in healthy soil are transplanted to smut-infected soil, the smut fungus can not attack them. The explanation seems to be that the smut threads are only able to penetrate the leaves of the young, tender seedlings. Flowers of sulphur have been used to sow with the seed in infested soil, and this remedy has given but slightly inferior results to any other yet tried.

The best method has proved to be that of formaldehyde drip with seeder. The formaldehyde solution is made at the rate of 1 pound of 40 per cent formaldehyde to 25 to 33 gallons of water. This is applied with drip attachment on seed drill at rate of 125 to 150 gallons per acre for field onions. The same results can be obtained in open furrows by applying solution with sprinkler

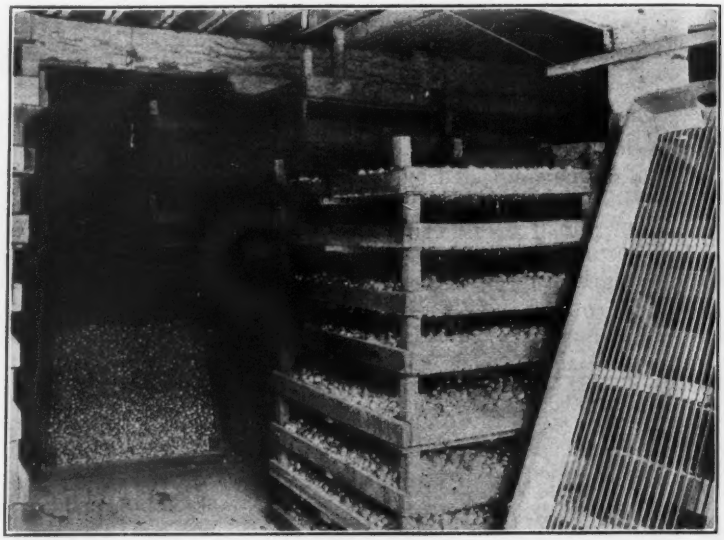

FIG. 11.—Onion sets stored on trays in a warehouse.

after seeds are scattered until well moistened. This formalin treatment insures the disinfection of a layer of soil near the seed and permits the germination and the early growth of the seedling onion past infection stage before the smut fungus can again occupy this soil. The gains from this treatment, both in the onion-set work and in field onions are very large, amounting to 100 to 200 per cent increase.[1]

The Maggot.

The onion maggot is often very destructive in fields that are just planted. This insect works at the roots of the young seedlings and is difficult to control.

The following methods of control have been suggested:

Carbolic-acid emulsion.—For all three forms of root maggots which we are considering, a carbolized form of kerosene emulsion is effective. This is pre-

[1] Ohio Agricultural Experiment Station Bulletin No. 214.

pared by adding to 1 pound of soap boiled in 1 gallon of water one-half gallon of crude carbolic acid and diluting the whole with from 35 to 50 parts of water. This mixture is applied about the stalks of the plants affected. It is best to use it a day or two after the plants are up or are transplanted, and repeat every week or 10 days until about the third week in May in the North. Farther south these applications must be made earlier in the season.

The use of mineral fertilizers.—Mineral fertilizers are useful as deterrents, particularly when employed just before or after a shower has thoroughly wet the ground. The principal fertilizers for this purpose are kainit, nitrate of soda, and sulphate or chlorid of potash. They may be used as top dressings before planting, or if not employed until afterwards, they should be applied as nearly as possible to the roots, the earth being turned away from the plants for this purpose. These fertilizers possess the advantage of acting also as a stimulant to plant growth, thereby facilitating recuperation from root-maggot attack.

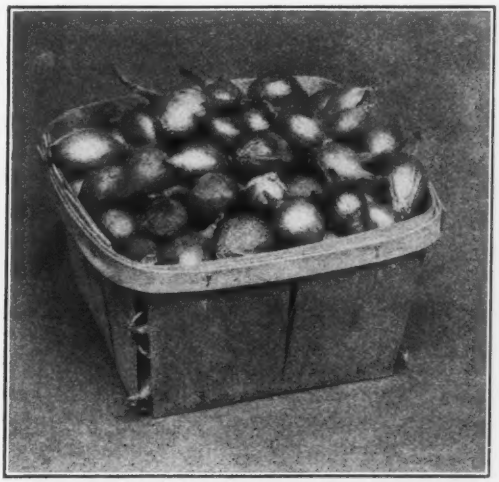

FIG. 12.—A quart of almost ideal onion sets.

Danger from use of organic fertilizers.—Stable manure and organic fertilizers are apt to induce infestation, since the species under consideration develops in excrement and other decomposing material. It is advisable, therefore, to avoid the use of manure, rotted leaves, or other organic fertilizers, and to avoid planting in fields in which there have have been infested or diseased plants.[1]

The Thrips.

The onion thrips belongs to the class of sucking insects, attacking the leaves and causing them first to assume a dull-gray or dirty appearance and afterwards to turn brown and die. This insect has proved very destructive, especially throughout the Southern States, and is now becoming quite a serious pest in the Bermuda-onion district of Texas. It is noticeable that insects of this character generally attack crops that are grown upon poor soils, that are late planted, and where the cultivation is neglected.

The remedies to be employed for the onion thrips are varied. Kerosene emulsion is of less value than for many other sucking insects; whale-oil soap is one of the standard remedies, and some of the tobacco or nicotine preparations have recently been found useful.

[1] Circular No. 63, Bureau of Entomology, U. S. Dept. of Agriculture.

PUBLICATIONS OF THE U. S. DEPARTMENT OF AGRICULTURE RELATING TO SEED PRODUCTION.

AVAILABLE FOR FREE DISTRIBUTION BY THE DEPARTMENT.

Onion Culture. (Farmers' Bulletin 354.)

Seed Corn. (Farmers' Bulletin 415.)

The Home Production of Onion Seed and Sets. (Farmers' Bulletin 434.)

Good Seed Potatoes and How to Produce Them. (Farmers' Bulletin 533.)

Saving Vegetable Seeds for the Home and Market Garden. (Farmers' Bulletin 884.)

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A Device for Sampling Grain, Seeds, and Other Material. (Department Bulletin 287.) Price, 5 cents.

The Vitality and Germination of Seeds. (Bureau of Plant Industry Bulletin 58.) Price, 10 cents.

How Seed Testing Helps the Farmer. (Separate 679 from Yearbook, 1915.) Price, 5 cents.

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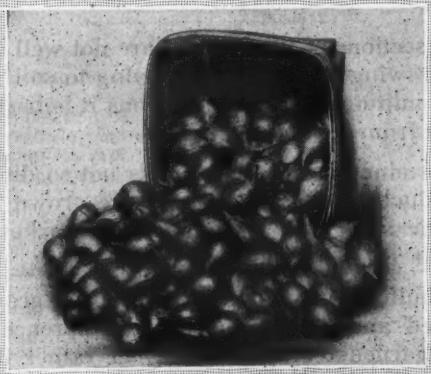
FARMERS' BULLETIN No. 434 rev. Jan. 1925

Rev.ed. follows

The HOME PRODUCTION OF ONION SEED AND SETS



MOST of the onion seed used in this country is produced by special growers. However, by growing his own seed the onion grower can secure strains better adapted to his particular conditions than by using seed bought on the general market. The grower can select a few bushels of mother bulbs from his entire crop, thus enabling him to save seed from choice specimens, while the commercial seed grower uses almost the entire crop for seed production.

The mother bulbs must be carefully stored so they will go through the winter without deterioration. Unless the grower has suitable storage it is best to secure seed from some one who has all the necessary facilities.

Some sections of the country are not well adapted to the growing of onion seed, owing to soil and climatic conditions. In these sections it is best to buy the seed from reputable growers.

The production of onion sets is not so difficult as the production of seed, as sets are grown in very much the same way as onions for market except that the seed is sown more thickly.

This bulletin gives directions for the growing of both seed and sets, with special reference to the market gardener and truck farmer rather than the seed grower.

Washington, D. C. Issued 1911; revised January, 1925

THE HOME PRODUCTION OF ONION SEED AND SETS[1]

By W. R. BEATTIE, *Horticulturist, Office of Horticulture, Bureau of Plant Industry*

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MANY of the leading onion growers of the Northern States are raising their own supplies of seed, and by so doing they procure a better grade than is obtainable in the general market. During the early history of onion-seed growing in this country the crop was practically all produced in small plantings. Later, the production of seed fell into the hands of a few large, speculative growers. During recent years there has been a tendency to return to former conditions.

Formerly the supply of onion seed came from farmers who selected seed bulbs of a uniform type year after year and in so doing established a definite strain; these bulbs were chosen from the entire crop of marketable onions, which permitted the selection of enough bulbs of the type desired for seed. In so doing the farmers were practicing selection, all bulbs not conforming to the desired type being discarded. In commercial onion-seed growing, where the bulbs are grown exclusively for seed purposes, it would not be profitable to discard all those that do not conform to the desired type.

It is customary for growers to select very carefully the few mother bulbs necessary to produce stock seed from which to grow their commercial crop of seed. In cases where commercial seed growers are short of bulbs for seed purposes, they frequently go into the market and purchase the best obtainable to make up the deficiency. Where a farmer is producing three or four thousand bushels of onions for the market from pedigree seed, it will be a comparatively easy matter for him to select from that quantity two or three hundred bushels of extra fine bulbs of the type desired for seed. Onion seed produced in this manner from selected bulbs and costing $1.50 a pound will in the end be cheaper than seed at 40 cents a pound that has come from a miscellaneous lot of bulbs taken as they run, without selection.

Unfortunately, the home production of onion seed is now more or less dependent upon the market price of onions the previous season. Many

[1] For the culture of onions for the general market, see Farmers' Bulletin No. 354, entitled "Onion Culture," which will be sent free on application to the Secretary of Agriculture.

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growers plant for seed only when they have failed to sell their crop, thus giving uncertainty and irregularity to the enterprise. There are a few farmers who plant a fairly uniform quantity of bulbs for seed each year, and who are making a decided success of the work.

Certain growers are better equipped than are others for the growing and handling of the seed and thus are in position to supply seed for the entire community. It has been found that carefully grown seed planted in the same general locality in which it is produced will give better results than seed brought from a distance; this is especially true in northern localities, where the season of growth is short, as southern-grown seed requires a longer season for its maturity.

The production of onion sets has been confined to a few localities. Now, however, the industry is receiving more general attention. Sets may be produced under a reasonably wide range of conditions, but in order to be successful it is essential that the grower should fully understand the principles and methods involved. The production of onion seed and sets is an important phase of the general onion industry, but owing to its more local nature it is treated separately.

HOME PRODUCTION OF ONION SEED

SELECTION AND CARE OF BULBS FOR SEED

The bulbs, or "mother bulbs," as they are commonly called, for the production of onion seed should be grown in the same manner as those intended for marketing, except that more care should be taken throughout. Some seed growers prefer to use 6 pounds of seed to an acre for the production of seed bulbs instead of 4 pounds, as ordinarily used in growing for market, in order that the bulbs may crowd and not become too large. The planting, culture, and harvesting of the bulbs are practically the same as for first-class marketable stock.

Onion-seed growing is a two-year process and two crops are constantly to be cared for. After growing the bulbs the first summer they must be stored over winter and replanted the following spring for the production of seed. Meantime the crop for the next year's planting must be coming on in order to have a crop of seed every year.

Onion seed can not be grown profitably in all parts of the country, for various reasons. Proper soil conditions are essential; also a climate that is free from extremes of temperature and rainfall. Certain localities in the Northeastern States near the ocean, around the Great Lakes, and on the Pacific coast are especially adapted to the production of onion seed.

The first requisite for the growing of the best seed is a clear-cut ideal of the exact shape, form, color, and general characteristics sought in the variety being grown. The second requisite is the growing of seed from bulbs of that exact type for the greatest possible number of generations.

Two selections should be made, the first to include but a small number of the very finest and most ideal bulbs from which to produce the stock seed to be used the following year for the growing of the seed bulbs, and the second to include the bulbs from which to grow the supply of seed for the market. By keeping the very best stock separate and using the product for propagation, the entire strain will be gradually improved. Bulbs a trifle below the ideal market size, or about 1½ to 2 inches in diameter, are the most profitable for seed production.

CARE OF BULBS DURING WINTER

Bulbs that are to be used for seed production should be allowed to become thoroughly ripe in the field. After pulling they should be stored in crates under a roof where they will have plenty of ventilation and be protected from sun and rain. Before freezing weather begins the onions should be graded and removed to a house where both ventilation and temperature can be controlled.

The temperature of the room in which the mother bulbs are stored should be kept as low as practicable under natural conditions without actual freezing. Onions freeze at a temperature of about 30.3° F., so a temperature a little above 30° will do no harm. Plenty of ventilation should also be provided for the storage room. Heat and moisture in the storage room will cause the onions to sprout during the storage period and render them almost worthless for seed purposes. In general, the storage conditions should be the same as for onions intended for the market.

SOILS ADAPTED TO THE GROWING OF SEED

Two types of soil may be used to advantage in growing onion seed. The soil upon which the bulbs are grown from seed should be quite rich and well supplied with organic matter and moisture. Good, rich sandy loam is best adapted to the growing of the bulbs. For the production of seed from bulbs, a soil that is well drained, fertile, and of a loamy nature is desirable. It is customary to grow the bulbs the first season on rich bottom land and to grow the seed the second season on well-drained upland. Soils containing an abundance of lime, such as are suited to the successful production of wheat, are adapted to onion-seed growing. The soil should be free from weed seeds and in a good state of tilth.

The bulbs for seed growing should not be set in a soil containing large quantities of fresh stable manure or green vegetable matter, but rather in a soil where some cultivated crop, such as corn, has been grown the previous season. Commercial fertilizers containing a small percentage of nitrogen, 6 to 8 per cent of available phosphoric acid, and 6 to 8 per cent of potash can be used to advantage at a rate not exceeding 1,000 pounds to the acre.

PREPARATION OF THE SOIL AND PLANTING

In preparing the land for setting the bulbs, apply the fertilizer and reduce the soil to a good state of tilth. Then mark off the land in rows about 2½ to 3½ feet apart by means of a one-horse plow, a corn marker, or some tool that will leave a decided furrow in which to set the bulbs. In some sections the rows are placed as close as 2 feet, but this hinders cultivation.

The bulbs should be placed by hand (fig. 1), root downward, from 3 to 6 inches apart, center to center, in the furrow. The usual rule is to set the bulbs so that the distance between them will be about equal to the diameter of the bulbs. The quantity of bulbs that may be set on an acre will depend largely upon their size, but may be as high as 250 bushels. Where the seed is to be employed for growing sets and overgrown sets are used as "mother" bulbs, the quantity required may be as low as 50 bushels to the acre. The bulbs should be placed in the ground sufficiently deep to be entirely below the surface of the soil when covered. As growth proceeds the soil should be drawn

FIG. 1.—Method of setting out bulbs for seed production

around the bulbs to form a support for the seed stalks.

CULTIVATION

Shallow cultivation should be given throughout, the object being to keep the land free from weeds and the soil worked toward the plants. Very little handwork will be necessary, except, perhaps, to go through after the seed heads have formed, remove the weeds, and draw the soil around the plants to hold the stalks erect and prevent the seed heads from blowing down and coming in contact with the soil.

TIME AND MANNER OF GATHERING THE SEED

The proper time to gather the seed is when the inside of the grain has reached the dough stage. Onion seed assumes its black color very early; in fact, before it has passed the watery stage and formed milk in the grain. This change of color is no indication of ripeness and very often deceives the inexperienced grower. The heads should be harvested just before the first-formed seed begins to shatter in handling.

Figure 2 shows a field of onions a short time before the seed is ripe. In harvesting, the heads are cut by hand, with 2 to 6 inches of the stem attached, and are placed in bags for transportation to the curing sheds.

CURING THE SEED HEADS

Any building having a tight floor and in which a free circulation of air can be maintained will serve as a curing place for onion seed. Many growers employ buildings similar to those used for curing tobacco, with the alternate vertical siding boards hinged so that they can be thrown open during good weather. In localities where rains do not occur during the curing period the seed heads are frequently dried on sheets of canvas stretched over frames or spread upon the ground.

FIG. 2.—Field of onion seed a short time before harvesting

For curing the seed in houses, wire-bottomed racks or trays placed one above the other are generally employed. As the seed is stirred from time to time during the curing process considerable of it will be shattered and fall upon the tray below or finally upon the floor. The main essentials in the curing of onion seed are to spread the heads very thinly, not over two heads in depth, and to give free ventilation. Even at a depth of

3 inches in the trays it will be necessary to stir them very often, especially during damp weather.

THRESHING AND CLEANING THE SEED

The date for gathering the seed depends upon the locality and climate, but as a rule this will be about midsummer or not later than August 15. The threshing and cleaning of the seed are often deferred until quite late in the autumn, except where the curing is done in the open air. Where large quantities of seed are produced the threshing is done with machines similar to regular grain threshers, but when grown on a small scale the seed is removed by beating with a flail.

After the seed has been threshed, there is still considerable danger of its heating or molding if left in too great bulk. The usual practice is to run it through a fanning mill to remove the dust and small particles of the heads or chaff that are broken up in threshing. In former years the method of cleaning was to place the seed in a tank of water, the heavy seed settling to the bottom of the tank, while the chaff and lighter portions could be floated off. This process is no longer used to any great extent, owing to the improvement in cleaning machinery and the danger of injuring the seed by the water. After the seed is fanned and most of the foreign matter removed, it should be spread thinly on the floor or canvas and stirred from time to time. About the only test that can be applied in order to detect moisture in the seed is that of feeling it with the hand, and anyone experienced in the handling of seed will soon become expert at determining when it is safe to bag it ready for storage or shipment.

YIELD OF SEED TO AN ACRE

The quantity of onion seed that can be grown on an acre depends on several conditions. In the first place this will be determined largely by the size of the bulbs that are planted. In the onion-set districts, where the seed with which to produce the sets is locally grown from overgrown sets, the quantity of seed is generally from 6 to 8 pounds to the bushel of bulbs planted. This seed, however, is not suitable for the production of standard market onions, and can be used for set growing only. In the production of seed from standard mother bulbs the yield is generally from 2 to 3 pounds of seed for every bushel of bulbs planted. This has been much higher in many cases, but 2½ pounds is generally considered satisfactory. The yield of seed as a rule will be about 400 pounds to the acre, although as high as 800 or even 1,000 pounds have been secured.

The price per pound paid for the seed varies according to the quality, variety, and market demands. For first-class high-grade seed from specially selected bulbs of desirable types the growers frequently receive two or three times as much per pound as for the general crop produced from bulbs not specially selected, which must be sold in competition with the great mass of seed produced by large growers.

When the cost of growing the bulbs, together with the preparation of the land, the keeping of the bulbs over winter, the necessity of handling them a large number of times, and the occupying of the land for two seasons is considered, it will be readily seen there is not a great profit in growing onion seed. However, there are quite a number of farmers who each year plant 2 or 3 acres to bulbs for seed and have for sale anywhere from 1,000 to 1,500 pounds of very choice seed. In many cases this represents the money crop of the farm. The extent to which this enterprise could be conducted with profit is doubtless limited, but the demand for high-grade seed of a distinct type is increasing each year. Anyone contemplating the growing of onion seed should carefully study local conditions and then operate in a small way until the necessary practices are understood.

PRODUCTION OF SEED FOR ONION-SET GROWING

Frequently the seed for onion-set growing is produced from bulbs selected from the sets themselves; in other words, the bulbs or mother bulbs are the overgrown sets. Near Louisville, Ky., the onion-set growers select the oversized bulbs and store them over winter. In the spring they send them to farmers in the hill country and have their supply of seed grown on bluegrass land which has not been heavily manured. In this way they are able to keep their onion seed free from disease and secure a higher vitality than if the seed were grown on the same land where the bulbs were produced.

Owing to the great quantity of seed employed in set growing it is desirable to secure it cheaply, and the bulbs

selected from the sets, being small, will produce a larger quantity of seed per bushel from mother bulbs than when grown in the usual manner. The stock seed bulbs should, however, be well matured, small necked, uniform in size, and selected according to an ideal shape. Onion seed from undersized bulbs is not so desirable, even for set growing, as that from standard bulbs.

After a crop of onion seed has been gathered it is the usual custom to plow up the bulbs and devote the land to some other crop. If the old bulbs are allowed to remain in the soil through the winter, especially if given slight protection, they will produce a small crop of seed the second season. This practice is not recommended except under special conditions where the land is not valuable or where it is particularly desirable to secure an additional quantity of seed from the bulbs.

CARE OF ONION SEED

The length of time that onion seed will retain its vitality depends largely upon maturity and climatic conditions. Well-matured seed will always keep better than poorly ripened and inferior seed. Under ordinary conditions onion seed loses its vitality very rapidly after the second year, especially if stored in a damp climate. It will often pay to ship the seed to a dry climate for storage.

PRODUCTION OF ONION SETS

CLIMATE AND SOILS ADAPTED TO ONION-SET GROWING

The term "set," as applied to the onion, indicates a small, undersized bulb which, when replanted in the ground, will produce a large onion. This method of producing onions is perhaps the oldest and now the most universally employed for the growing of small areas of onions in the garden and where an early crop is desired. The common method of producing sets is to plant a large quantity of seed on a small area of rather rich land and thus produce a great number of bulbs that are undersized, owing to crowding and lack of plant food. The greater number of these bulbs do not attain sufficient size or maturity to produce seed the following season and are really plants in which the process of growth has been arrested.

In the United States the onion-set industry is largely confined to a few areas. The crop is extensively grown near Louisville, Ky., Chillicothe, Ohio, and Chicago, Ill., in the Platte River Valley of Nebraska, in southwestern New Jersey, and in southern California. The entire area devoted to this enterprise in these localities is estimated at from 2,500 to 3,000 acres. The yield to the acre varies with the locality, but will average about 300 bushels. The market for onion sets is found throughout the entire country, the greater portion being disposed of in small quantities.

The climatic conditions governing the production of onion sets are practically the same as those for standard onions, although it is not necessary to plant quite so early in the spring. Onion sets can undoubtedly be grown in any part of the Northern States where suitable soil conditions can be obtained. The soil adapted to onion-set culture is as a rule about the same as that required for the growing of large onions, except that the land should not be so rich.

In the Louisville district the soil is a clay loam, containing plenty of lime. This soil, by the use of fertilizer, will yield 250 to 350 bushels of mature onions and will produce an equal quantity of sets, but the fertilizer requirements for the latter are not so great. This land is underlain at a depth varying from 18 inches to 10 or 12 feet by limestone and is a natural bluegrass soil, retentive of moisture, and comparatively free from weeds.

In the vicinity of Chillicothe, Ohio, the soil is a river-bottom loam, being principally the washings from the hills. This soil contains occasional small beds of gravel, but owing to its silty nature it is retentive of moisture and easily cultivated.

In the Chicago area we find a variation in soil texture. In the vicinity of South Chicago the area devoted to onion-set growing was formerly a sewage-disposal farm and is laid off in regular level beds. This soil is of a sandy, loamy nature and is very similar to the river-bottom lands at Chillicothe. Northwest of Chicago the soil is a more gravelly loam, although in some places it is of a river-bottom or silty nature.

In southwestern New Jersey the soil is a sandy loam, not unlike the Norfolk sandy loam, although it contains more or less gravel, and in places the clay approaches the surface.

It will be seen that onion sets can be grown on any land that is adapted

to general truck crops, the main essential being freedom from weeds and a reasonably high state of tillage.

PREPARATION OF THE SOIL

In preparing the land for onion-set growing the work should be performed in practically the same manner as for regular crops of onions. The plowing need be only moderately deep, but the soil must be brought to a smooth, fine surface, suitable for the proper sowing of the seed by means of hand drills. The tools generally employed for this purpose are the plow, disk harrow, roller, smoothing harrow, and sometimes a pull or drag made of scantlings or planks. A harrow of the type shown in Figure 3 is adapted to the final preparation before planting.

On some land onion sets have been grown continuously year after year without any appreciably injurious results. In other localities it has been found necessary to adopt a crop-rotation system, and this is advisable wherever the quantity of available land is sufficient. A rotation including corn, potatoes, onion sets, and clover will be found quite satisfactory.

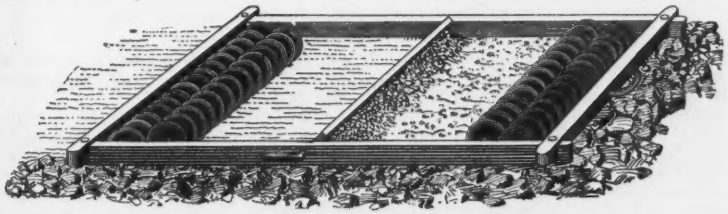

FIG. 3.—Harrow for leveling soil for planting seed

FERTILIZERS

In preparing the land for growing onion sets large quantities of barnyard manure should not be applied immediately before planting. If barnyard manure is to be employed, it should be used the previous season on some other crop, in order that it may become fully incorporated with the soil and in a measure subdued. Commercial fertilizers may be employed profitably in moderate quantities, say 600 to 1,200 pounds to the acre, and should be broadcasted at the time of fitting the land. This fertilizer should contain about 4 or 5 per cent of nitrogen, 6 or 8 per cent of available phosphoric acid, and 8 or 10 per cent of potash.

SOWING THE SEED

As the essential feature of growing onion sets is the crowding together of the plants in the rows, a large quantity of seed is required to plant an acre. The quantity of seed required varies with the different localities. In the vicinity of Louisville, Ky., from 55 to 60 pounds to the acre are sown; Chillicothe, Ohio, 40 to 50 pounds; Chicago, 55 to 120 pounds; while in New Jersey as low as 25 pounds to the acre are used.

The drills employed for seeding are, as a rule, the hand seeders usually found upon the market used for sowing the seed of all small truck crops. In some localities, however, special seeders have been designed in order to distribute the seed in a particular manner. Near Chillicothe, Ohio, many of the growers employ a drill having five small teeth similar to the shoes of an ordinary grain drill, but on a very small scale. (See fig. 4.)

These seeders distribute the seed in five little drills about an inch apart, making a broad belt of five rows. Another method is to place a funnel-shaped spreader on the under part of the drill, which scatters the seed over an area of 3 or 4 inches in width.

DISTANCES TO PLANT AND QUANTITY OF SEED REQUIRED

The distance between the rows ranges from 7 to 14 inches, but varies with the method of sowing. The larger yields are obtained by sowing in single drills about 9 inches between the rows and using 65 to 85 pounds of seed to the acre. Most growers endeavor to sow their onion seed as early as the land can be put in first-class condition. Formerly the seeds for sets were not sown until late in the season, but it has been found that larger yields of sets can be obtained and that the sets will ripen better if the seed is sown early.

The New Jersey growers have found it more profitable to grow a sort of mixed crop, including all sizes from sets to marketable onions. A smaller quantity of seed is employed per acre, within six or eight days after planting. It is desirable that the soil should be stirred frequently and that the weeds should never be given an opportunity to gain a foothold. The

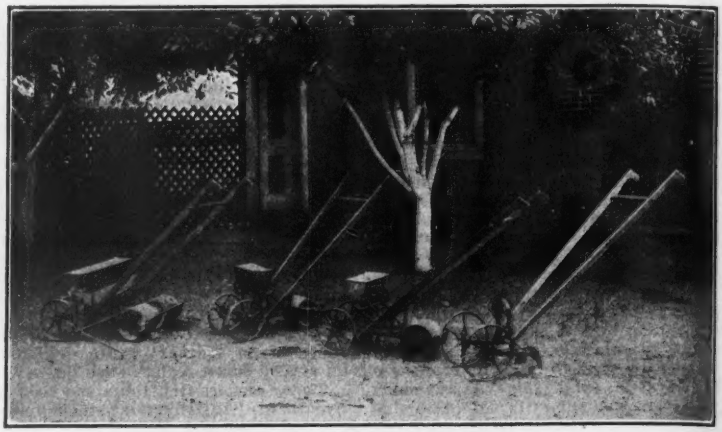

FIG. 4.—Special tools for planting and cultivating onion sets

but, on the other hand, the method of growing is somewhat different, and a larger percentage of overgrown bulbs is secured. Those that are below standard size are sold as "boilers" or "stewers," "picklers," and "sets." By using about 25 pounds of first-class seed to the acre and planting in rows 24 inches apart these growers are enabled to employ horse culture and succeed in growing about 300 bushels of all sizes to the acre. This method of planting does not

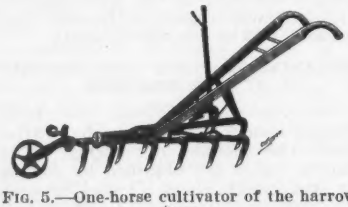

FIG. 5.—One-horse cultivator of the harrow type

greatly decrease the yield and at the same time reduces the cost of cultivation.

CULTIVATION

As a rule onion seed will germinate and the plants appear above ground so that the rows can be followed onion sets should be cultivated at least once every week during their growing period.

The tools employed are for the most part of the wheel-hoe type, of which there are a number of forms. These tools are provided with numerous attachments for cutting close to the plants, for throwing the soil away from the rows, and for leveling and working it back around them. Some of the Chicago growers have adopted a special wheel hoe of their own design, using the front wheel of a bicycle and a pair of light-weight plow handles for the frame, to which the various types of sweeps and shovels are attached. In New Jersey horse tools are employed almost exclusively, the 14 or 15 tooth harrow-type cultivator (fig. 5) being the favorite.

Hand weeding seems to be an essential in all localities, although this laborious process can be eliminated to some extent by proper wheel-hoe and horse cultivation. The cost of the cultivation of an acre of onion sets during the season should not exceed $100, and this may be reduced considerably if the land is in proper condition and the work is handled at the right time. Hand weeding in most cases will be necessary twice during the growth of the crop. During rainy

seasons it is often found impossible to keep certain areas clean, and when the weeds once become well established there is very little hope of saving the crop. When the sets have attained considerable growth the tops shade the ground and prevent, in a measure, the growth of weeds. After this stage has been reached very little attention will be required. In fact, the stirring of the soil should cease before the sets show any tendency to ripen. Figure 6 will give some idea of the appearance of an onion-set field at the period of its maximum development.

FIG. 6.—Hand weeding an onion-set field during early summer

HARVESTING AND CURING

The time for harvesting is just when the sets begin to ripen. This generally occurs about July 4 in southern localities and July 20 near Chicago, or 90 to 110 days from the date of sowing the seed. The methods of harvesting are different in the several localities. Near Louisville, Ky., the sets are allowed to become quite ripe before harvesting.

At harvest time the sets are loosened from the soil by means of a cutter attached to a wheel hoe or with broad forks having 10 or 12 tines. They are then pulled by hand, as shown in Figure 7, the tops twisted off by hand, and the bulbs sifted and placed upon trays to dry. These trays are piled one upon another in the field (fig. 8) with a space of 3 or 4 inches between and a temporary roof placed over them. They are allowed to remain upon these trays until quite dry and are again screened and removed to the storehouse.

Near Chillicothe, Ohio, the sets are pulled while yet quite green and stacked in the field in long, narrow ridges (figs. 9 and 10), the bulbs being placed underneath so that the tops will protect them from sunlight and rain. After remaining in these ridges about two weeks, the tops are twisted off and the bulbs placed upon screens to dry. From the screens they are hauled to the warehouse where the fanning and cleaning take place.

Near Chicago the practice of pulling is very similar to that in the vicinity of Louisville, the tops being twisted off as the sets are removed from the soil. In New Jersey the sets are allowed to become fully ripe before being removed from the soil and are harvested and cured together with the larger bulbs, after which they are separated by fanning and screening.

After pulling, it is essential that the sets be subjected to a drying process; during this process they require plenty

of ventilation. This can be most easily secured by spreading the sets on trays, commonly called crates, that are provided with corner pieces extending 4 or 5 inches above the sides of the trays. As a rule these trays are constructed with 3-inch sides, about 5 feet square, with slat or wire bottoms, and hold about 3 bushels of onion sets. When the trays are piled one upon another the corner pieces provide an air space above each tray, thus securing the best possible ventilation. In the absence of corner pieces blocks of wood or broken bricks are employed, as shown in Figure 8. A roof of boards is placed over each stack of trays to protect the onion sets from the sun and rain.

FIG. 7.—Harvesting onion sets near Louisville, Ky.

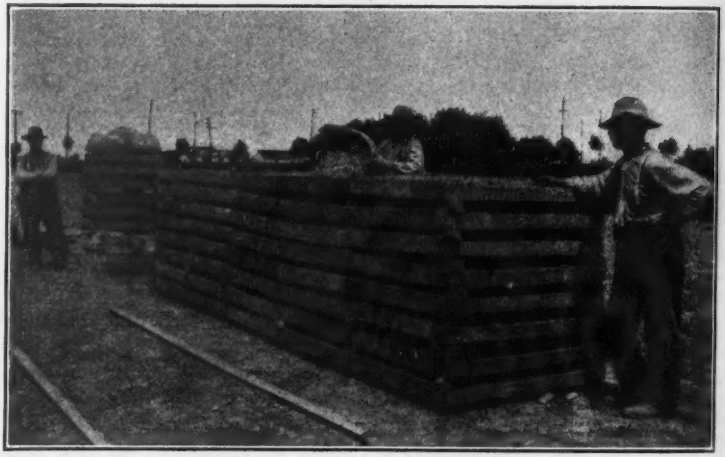

FIG. 8.—Onion sets drying on trays piled in a field.

STORING ONION SETS

The method of storage is essentially the same in all localities, the tray

previously described being most commonly used. (Fig. 11.) When the sets have become sufficiently dry some growers transfer them to the 1-bushel crates, in which they are shipped. Onion sets are stored under conditions similar to those required for large onions, the essentials being plenty of ventilation, dryness, and a comparatively low temperature. Slight freezing will not destroy them, provided they are not disturbed while frozen. However, freezing is always injurious and has a tendency to cause them to sprout earlier in the spring. If a uniform temperature 2 or 3 degrees above freezing can be maintained, it is more satisfactory than too frequent variation.

In preparing the sets for market they are first passed through a fanning mill, which removes all loose skins, earth, or shriveled bulbs, and then over a screen which removes any bulbs that are too large for the market demands. After this they are shipped in 1-bushel crates, burlap bags, or barrels.

The crate is perhaps most desirable as a shipping package, as it protects the bulbs and allows a free circulation of the air. When shipped in bags the sets are liable to become injured, except where they are handled in carload lots. Tight barrels are objectionable unless the sets are thoroughly cured, as there is liability to heat in the center.

FIG. 9.—"Stacking" onion sets to cure in a field.

Some growers employ a form of open shed as a temporary storage place for the sets during the autumn months or until cold weather begins. A few growers store their crop until late winter and sell direct to seedsmen and dealers, but the majority turn their sets over to warehousemen for storage and disposal. Throughout the storage period the sets should be handled as little as possible and should be kept spread out thinly, so there will be no chance of heating. Onions in storage are constantly giving off more or less moisture and are liable to become damp and sprout if stored in too great bulk.

PROPER SIZE OF ONION SETS

The ideal onion set is almost globular in shape and a trifle less than half an inch in diameter. The illustration on the title-page shows a quart of first-class onion sets. The color should be bright and the surface free from smut or spots of any kind. The term "pickler" is applied to the onion just above sets in size, or, in other words, one-half to three-fourths of an inch in diameter. The term "boiler," or "stewer," is applied to the size next larger than picklers, or from three-fourths of an inch to 1¼ inches in diameter, which are too small for sale as standard onions.

FIG. 10.—Onion sets curing in "stacks"

FIG. 11.—Onion sets stored on trays in a warehouse

Another type of bulblet sometimes sold for propagation is that of the "top" or "multiplier" onion. These bulblets are formed on the top of a stalk similar to a flower stalk and if planted will produce a fair-sized bulb. If the bulbs are allowed to remain in the soil they will throw up stalks the following season and produce bulblets for further planting. This variety is extensively used for the production of young onions which are peeled, bunched, and marketed during the early spring. The bulblets are planted closely, either in beds or in rows, during the late autumn, and the young onions will be ready for use early in the spring. In cold climates slight protection will be required in order to carry the planted bulbs safely through the winter.

VARIETIES OF ONIONS USED FOR SETS

Seed of almost any variety of onion may be used for the production of sets, but a greater demand exists for the distinctly yellow, white, and red colors. In the trade the sets are recognized by their color rather than by actual varietal names. The demand for the yellow and the white sets is greater than for the red, and those of the globular type are generally preferred.

Onion sets are sometimes grown from left-over seed, in which case a large number of varieties may be included. In the principal set-growing districts, where the seed has been locally grown for many years, the varieties are more or less distinct from those of seedsmen's catalogues.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

March 14, 1928

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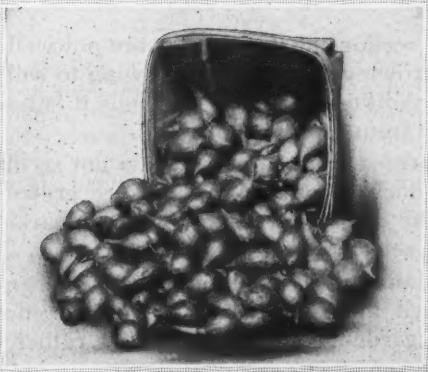
The HOME PRODUCTION OF ONION SEED AND SETS



MOST of the onion seed used in this country is produced by special growers. However, by growing his own seed the onion grower can secure strains better adapted to his particular conditions than by using seed bought on the general market. The grower can select a few bushels of mother bulbs from his entire crop, thus enabling him to save seed from choice specimens, while the commercial seed grower uses almost the entire crop for seed production.

The mother bulbs must be carefully stored so they will go through the winter without deterioration. Unless the grower has suitable storage it is best to obtain seed from some one who has all the necessary facilities.

Some sections of the country are not well adapted to the growing of onion seed, owing to soil and climatic conditions. In these sections it is best to buy the seed from reputable growers.

The production of onion sets is not so difficult as the production of seed, as sets are grown in very much the same way as onions for market except that the seed is sown more thickly.

This bulletin gives directions for the growing of both seed and sets, with special reference to the market gardener and truck farmer rather than the seed grower.

Washington, D. C. Issued 1911; revised May, 1930

THE HOME PRODUCTION OF ONION SEED AND SETS[1]

By W. R. BEATTIE, *Senior Horticulturist, Office of Horticultural Crops and Diseases, Bureau of Plant Industry*

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INTRODUCTION

Many of the leading onion growers of the Northern States are raising their own supplies of seed, and by so doing they procure a better grade than is obtainable in the general market. During the early history of onion-seed growing in this country the crop was practically all produced in small plantings. Later, the production of seed fell into the hands of a few large, speculative growers. During recent years there has been a tendency to return to former conditions.

Formerly the supply of onion seed came from farmers who selected seed bulbs of a uniform type year after year and in so doing established a definite strain; these bulbs were chosen from the entire crop of marketable onions, which permitted the selection of enough bulbs of the type desired for seed. In so doing the farmers were practicing selection, all bulbs not conforming to the desired type being discarded. In commercial onion-seed growing, where the bulbs are grown exclusively for seed purposes, it would not be profitable to discard all those that do not conform to the desired type.

It is customary for growers to select very carefully the few mother bulbs necessary to produce stock seed from which to grow their commercial crop of seed. In cases where commercial seed growers are short of bulbs for seed purposes, they frequently go into the market and purchase the best obtainable to make up the deficiency. Where a farmer is producing 3,000 to 4,000 bushels of onions for the market

[1] For the culture of onions for the general market, see Farmers' Bulletin No. 354, Onion Culture, which will be sent free on application to the United States Department of Agriculture.

from pedigree seed, it is a comparatively easy matter for him to select from that quantity 200 to 300 bushels of extra fine bulbs of the type desired for seed. Onion seed produced in this manner from selected bulbs and costing $1.50 a pound will be cheaper in the end than seed at 40 cents a pound that has come from a miscellaneous lot of bulbs taken as they run without selection.

Unfortunately, the home production of onion seed is now more or less dependent upon the market price of onions the previous season. Many growers plant for seed only when they have failed to sell their crop, thus giving uncertainty and irregularity to the enterprise. There are a few farmers who plant a fairly uniform quantity of bulbs for seed each year and who are making a decided success of the work.

Certain growers are better equipped than others for the growing and handling of the seed and thus are in position to supply seed for the entire community. It has been found that carefully grown seed planted in the same general locality in which it is produced will give better results than seed brought from a distance; this is especially true in northern localities, where the season of growth is short, as southern-grown seed requires a longer season for its maturity.

The production of onion sets has been confined to a few localities. Sets may be produced under a reasonably wide range of conditions, but in order to be successful it is essential that the grower should fully understand the principles and methods involved. The production of onion seed and sets is an important phase of the general onion industry, but owing to its more local nature it is treated separately.

PRODUCTION OF ONION SEED

SELECTION AND CARE OF BULBS FOR SEED

The bulbs, or "mother bulbs," as they are commonly called, for the production of onion seed should be grown in the same manner as those intended for marketing, except that more care should be taken throughout. Some seed growers prefer to use 6 pounds of seed to an acre for the production of seed bulbs instead of 4 pounds, as ordinarily used in growing for market, in order that the bulbs may crowd and not become too large. The planting, culture, and harvesting of the bulbs are practically the same as for first-class marketable stock.

Onion-seed growing is a 2-year process and two crops are constantly to be cared for. After growing the bulbs the first summer they must be stored over winter and replanted the following spring for the production of seed. Meantime the crop for the next year's planting must be coming on in order to have a crop of seed every year.

Onion seed can not be grown profitably in all parts of the country, for various reasons. Proper soil conditions are essential; also a climate that is free from extremes of temperature and rainfall. Certain localities in the Northeastern States near the ocean, around the Great Lakes, and on the Pacific coast are especially adapted to the production of onion seed.

The first requisite for the growing of the best seed is a clear-cut ideal of the exact shape, form, color, and general characteristics sought in the variety being grown. The second requisite is the growing of seeds from bulbs of that exact type for the greatest possible number of generations.

Two selections should be made, the first to include but a small number of the very finest and most ideal bulbs from which to produce the stock seed to be used the following year for the growing of the seed bulbs, and the second to include the bulbs from which to grow the supply of seed for the market. By keeping the very best stock separate and using the product for propagation, the entire strain will be gradually improved. Bulbs a trifle below the ideal market size, or about 1½ to 2 inches in diameter, are the most profitable for seed production.

CARE OF BULBS DURING WINTER

Bulbs that are to be used for seed production should be allowed to become thoroughly ripe in the field. After pulling they should be stored in crates under a roof where they will have plenty of ventilation and be protected from sun and rain. Before freezing weather begins the onions should be graded and removed to a house where both ventilation and temperature can be controlled.

The temperature of the room in which the mother bulbs are stored should be kept as near 45° F. as possible. Experimental work shows that storing mother bulbs at temperatures below 40° for any considerable period of time greatly reduces the production of seed heads and seeds. If the storage temperature is allowed to go above 50° for more than a few days there may be considerable losses from sprouting. The storage room should be well ventilated, since high humidity is conducive to the development of disease.

SOILS ADAPTED TO THE GROWING OF SEED

Two types of soil may be used to advantage in growing onion seed. The soil upon which the bulbs are grown from seed should be quite rich and well supplied with organic matter and moisture. Good rich sandy loam is best adapted to the growing of the bulbs. For the production of seed from bulbs a soil that is well drained, fertile, and of a loamy nature is desirable. It is customary to grow the bulbs the first season on rich bottom land and to grow the seed the second season on well-drained upland. Soils containing an abundance of lime, such as are suited to the successful production of wheat, are adapted to onion-seed growing. The soil should be free from weed seeds and in a good state of tilth.

The bulbs for seed growing should not be set in a soil containing large quantities of fresh stable manure or green vegetable matter, but rather in a soil where some cultivated crop, such as corn, has been grown the previous season. Commercial fertilizers containing a small percentage of nitrogen, 6 to 8 per cent of available phosphoric acid, and 6 to 8 per cent of potash can be used to advantage at a rate not exceeding 1,000 pounds to the acre.

PREPARATION OF THE SOIL AND PLANTING

In preparing the land for setting the bulbs, apply the fertilizer and reduce the soil to a good state of tilth. Then mark off the land in rows about 2½ to 3½ feet apart by means of a 1-horse plow, a corn marker, or some tool that will leave a decided furrow in which to set the bulbs. In some sections the rows are placed as close as 2 feet, but this hinders cultivation.

The bulbs should be placed by hand (fig. 1), root downward, from 3 to 6 inches apart, center to center, in the furrow. The usual rule is to set the bulbs so that the distance between them will be about 4 inches.

The quantity of bulbs that may be set on an acre will depend largely upon their size, but may be as high as 250 bushels. Where the seed is to be employed for growing sets and overgrown sets are

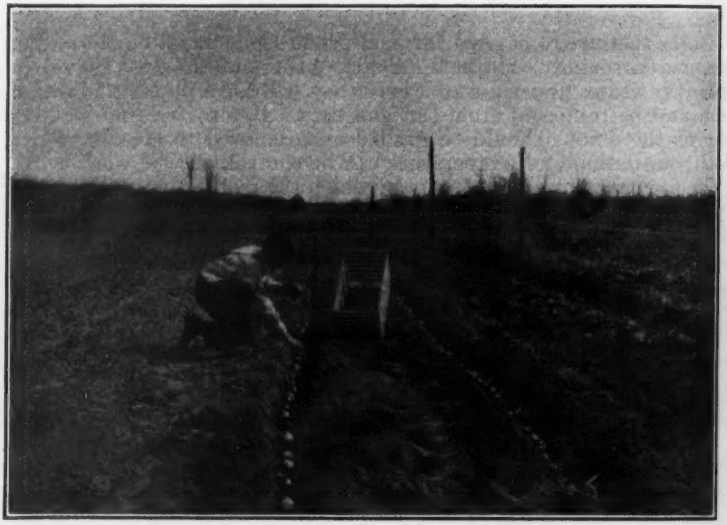

FIGURE 1.—Method of setting out bulbs for seed production

used as mother bulbs, the quantity required may be as low as 50 bushels to the acre.

The bulbs should be placed in the ground sufficiently deep to be entirely below the surface of the soil when covered. As growth proceeds the soil should be drawn around the bulbs to form a support for the seed stalks.

CULTIVATION

Shallow cultivation should be given throughout, the object being to keep the land free from weeds and the soil worked toward the plants. Very little handwork will be necessary, except, perhaps, to go through after the seed heads have formed, remove the weeds, and draw the soil around the plants to hold the stalks erect and prevent the seed heads from blowing down and coming in contact with the soil.

TIME AND MANNER OF GATHERING THE SEED

The proper time to gather the seed is when the inside of the grain has reached the dough stage. Onion seed assumes its black color very early; in fact, before it has passed the watery stage and formed milk in the grain. This change of color is no indication of ripeness and very often deceives the inexperienced grower. The heads should be harvested just before the first-formed seed begins to shatter in handling. Two or three cuttings of the seed should be made, about 20 per cent of the heads being removed at the first cutting.

Figure 2 shows a field of onions a short time before the seed is ripe. In harvesting, the heads are cut one at a time by hand, with a very short piece of the stem attached, and are placed in bags for transportation to the curing sheds.

FIGURE 2.—Field of onion seed a short time before harvesting

CURING THE SEED HEADS

Any building having a tight floor and in which a free circulation of air can be maintained will serve as a curing place for onion seed. Many growers employ buildings similar to those used for curing tobacco, with the alternate vertical siding boards hinged so that they can be thrown open during good weather. In localities where rains do not occur during the curing period the seed heads are frequently dried on sheets of canvas stretched over frames or spread upon the ground.

For curing the seed in houses, wire-bottomed racks or trays placed one above the other are generally employed. As the seed is stirred from time to time during the curing process considerable of it will

be shattered and will fall upon the tray below or finally upon the floor. The main essentials in the curing of onion seed are to spread the heads very thinly, not over two heads in depth, and to give free ventilation. Even at a depth of 3 inches in the trays it will be necessary to stir them very often, especially during damp weather.

THRESHING AND CLEANING THE SEED

The date for gathering the seed depends upon locality and climate, but as a rule this will be about midsummer or not later than August 15. The threshing and cleaning of the seed are often deferred until quite late in the autumn, except where the curing is done in the open air. Where large quantities of seed are produced the threshing is done with special machines, but when grown on a small scale the seed is removed by beating with a flail.

After the seed has been threshed or beaten from the heads there is still considerable danger of its heating or molding if left in too great bulk. The usual practice is to run it through a fanning mill to remove the dust and the small particles of stems, heads, or chaff that are broken up in the threshing. Where the special threshing machines are employed these have a fanning attachment which removes most of the trash.

In California, where a large part of the supply of onion seed is grown, the seed is washed immediately after threshing and is then spread on canvas sheets to dry. In washing, the seed is poured slowly from the bags into a trough of water, the heavy seed settling to the bottom and the lighter seed and the chaff rising to the surface. The seed is then thoroughly stirred so as to permit all of the lighter seed to float. The lighter materials are floated off and the heavier seed lifted out immediately and spread out to dry. It is important that the seed be not allowed to remain in the water more than 30 minutes, and on being taken from the water it should be spread thinly on wire-bottom trays or on canvas to dry. In order that it may become partially dry before nightfall, the seed should never be washed on a damp day or late in the day. On the day following washing, the seed should be frequently stirred with the hands, a board, or a wooden rake. Although the seed may appear to be perfectly clean after drying, there is always some light or shriveled seed present, and it is necessary to put the seed again through the fanning mill once or possibly twice to get out all of the inferior seed.

In sections where the seed can not be dried quickly it is not safe to wash it, but it should be cleaned entirely by means of cleaning machinery. It is not safe to bag the seed and store it until it is thoroughly dry.

YIELD OF SEED TO AN ACRE

The quantity of onion seed that can be grown on an acre depends on several conditions. In the first place, this will be determined largely by the size of the bulbs that are planted. In the onion-set districts, where the seed with which to produce the sets is locally grown from overgrown sets, the quantity of seed is generally from 6 to 8 pounds to the bushel of bulbs planted. This seed, however, is not suitable for the production of standard market onions and can be

used only for set growing. In the production of seed from standard mother bulbs the yield is generally from 2 to 3 pounds of seed for every bushel of bulbs planted. The yield has been much higher in many cases, but 2½ pounds is generally considered satisfactory. The yield of seed as a rule will be about 400 pounds to the acre, although as high as 800 or even 1,000 pounds have been secured. White varieties produce a smaller quantity of seed than the brown and yellow varieties.

The price per pound paid for the seed varies according to the quality, variety, and market demands. For first-class high-grade seed from specially selected bulbs of desirable types the growers frequently receive two or three times as much per pound as for the general crops produced from bulbs not specially selected, which must be sold in competition with the great mass of seed produced by large growers.

When the cost of growing the bulbs, together with the preparation of the land, the keeping of the bulbs over winter, the necessity of handling them a large number of times, and the occupying of the land for two seasons are considered, it will be readily seen that there is not a great profit in growing onion seed. However, there are many farmers who each year plant 2 or 3 acres to bulbs for seed and have for sale anywhere from 1,000 to 1,500 pounds of very choice seed. In many cases this represents the money crop of the farm.

The extent to which this enterprise could be conducted with profit is doubtless limited, but the demand for high-grade seed of a distinct type is increasing each year. Anyone contemplating the growing of onion seed should carefully study local conditions and then operate in a small way until the necessary practices are understood.

PRODUCTION OF SEED FOR ONION-SET GROWING

Frequently the seed for onion-set growing is produced from bulbs selected from the sets themselves; in other words, the bulbs or mother bulbs are the overgrown sets. Near Louisville, Ky., the onion-set growers select the oversized bulbs and store them over winter. In the spring they send them to farmers in the hill country and have their supply of seed grown on bluegrass land which has not been heavily manured. In this way they are able to keep their onion seed free from disease and to obtain a higher vitality than if the seed were grown on the same land where the bulbs were produced.

Owing to the great quantity of seed employed in set growing, it is desirable to secure it cheaply, and the bulbs selected from the sets, being small, will produce a larger quantity of seed per bushel from mother bulbs than when grown in the usual manner. The stock seed bulbs should, however, be well matured, small necked, uniform in size, and selected according to an ideal shape. Onion seed from undersized bulbs is not so desirable, even for set growing, as that from standard bulbs.

After a crop of onion seed has been gathered it is the usual custom to plow up the bulbs and devote the land to some other crop. If the old bulbs are allowed to remain in the soil through the winter, especially if given slight protection, they will produce a small crop of seed the second season. This practice is not recommended except

under special conditions where the land is not valuable or where it is particularly desirable to obtain an additional quantity of seed from the bulbs.

CARE OF ONION SEED

The length of time that onion seed will retain its vitality depends largely upon maturity and climatic conditions. Well-matured seed will always keep better than poorly ripened and inferior seed. Under ordinary conditions onion seed loses its vitality very rapidly after the second year, especially if stored in a damp climate. It will often pay to ship the seed to a dry climate for storage.

PRODUCTION OF ONION SETS

CLIMATE AND SOILS ADAPTED TO ONION-SET GROWING

The term "set," as applied to the onion, indicates a small, undersized bulb which, when replanted in the ground, will produce a large onion. This method of producing onions is perhaps the oldest and now the most universally employed for the growing of small areas of onions in the garden and where an early crop is desired. The common method of producing sets is to plant a large quantity of seed on a small area of fairly rich land and thus produce a great number of bulbs that are undersized, owing to crowding and lack of plant food. The greater number of these bulbs do not attain sufficient size or maturity to produce seed the following season and are really plants in which the process of growth has been arrested.

In the United States the onion-set industry is largely confined to a few areas. The crop is extensively grown near Louisville, Ky., Chicago, Ill., in the Platte River Valley of Nebraska, in southwestern New Jersey, and in southern California. The entire area devoted to this enterprise in these localities is estimated at from 2,500 to 3,000 acres. The yield to the acre varies with the locality, but will average about 300 bushels. The market for onion sets is found throughout the entire country, the greater portion being disposed of in small quantities.

The climatic conditions governing the production of onion sets are practically the same as those for standard onions, although it is not necessary to plant quite so early in the spring. Onion sets can undoubtedly be grown in any part of the Northern States where suitable soil conditions can be obtained. The soil adapted to onion-set culture is as a rule about the same as that required for the growing of large onions, except that the land should not be so rich.

In the Louisville district the soil is a clay loam containing plenty of lime. This soil, by the use of fertilizer, will yield 250 to 350 bushels of mature onions and will produce an equal quantity of sets, but the fertilizer requirements for the latter are not so great. This land is underlain at a depth varying from 18 inches to 10 or 12 feet by limestone and is a natural bluegrass soil, retentive of moisture, and comparatively free from weeds.

In the Chicago area there is a variation in soil texture. In the vicinity of South Chicago the area devoted to onion-set growing was formerly a sewage-disposal farm and is laid off in regular level beds. This soil is of a sandy, loamy nature and is very similar to

river-bottom lands. Northwest of Chicago the soil is a more gravelly loam, although in some places it is of a river-bottom or silty nature.

In southwestern New Jersey the soil is a sandy loam, not unlike the Norfolk sandy loam, although it contains more or less gravel, and in places the clay approaches the surface.

It will be seen that onion sets can be grown on any land that is adapted to general truck crops, the main essential being freedom from weeds and a reasonable high state of tillage.

PREPARATION OF THE SOIL

In preparing the land for onion-set growing the work should be performed in practically the same manner as for regular crops of onions. The plowing need be only moderately deep, but the soil must be brought to a smooth, fine surface, suitable for the proper sowing of the seed by means of hand drills. The tools generally employed for this purpose are the plow, disk harrow, roller, smoothing harrow, and sometimes a pull or drag made of scantlings or planks. A harrow of the type shown in Figure 3 is adapted to the final preparation before planting.

On some land onion sets have been grown continuously year after year without any appreciably injurious results. In other localities

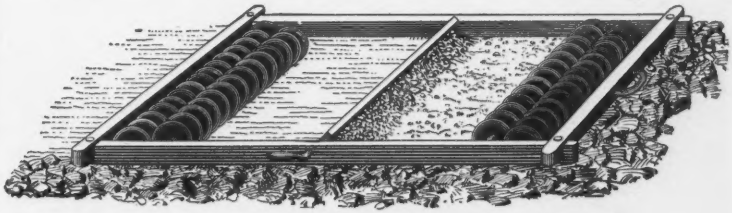

FIGURE 3.—Harrow for leveling soil for planting onion seed

it has been found necessary to adopt a crop-rotation system, and this is advisable wherever the quantity of available land is sufficient. A rotation including corn, potatoes, onion sets, and clover will be found quite satisfactory.

FERTILIZERS

In preparing the land for growing onion sets large quantities of barnyard manure should not be applied immediately before planting. If barnyard manure is to be employed, it should be used the previous season on some other crop, in order that it may become fully incorporated with the soil and in a measure subdued.

Commercial fertilizers may be employed profitably in moderate quantities, say 600 to 1,200 pounds to the acre, and should be broadcast at the time of fitting the land. This fertilizer should contain about 4 to 5 per cent of nitrogen, 6 to 8 per cent of available phosphoric acid, and 8 to 10 per cent of potash.

SOWING THE SEED

As the essential feature of growing onion sets is the crowding together of the plants in rows, a large quantity of seed is required

to plant an acre. The quantity of seed required varies with the different localities. In the vicinity of Louisville, Ky., from 55 to 60 pounds to the acre are sown; Colorado, 100 pounds; Chicago, 55 to 120 pounds; while in New Jersey as low as 25 pounds to the acre are used.

The drills employed for seeding are, as a rule, the hand seeders usually found upon the market used for sowing the seed of all small truck crops. In some localities, however, special seeders have been designed in order to distribute the seed in a particular manner. (Fig. 4.) These seeders distribute the seed in five little drills about an inch apart, making a broad belt of five rows. Another method is to place a funnel-shaped spreader on the under part of the drill, which scatters the seed over an area of 3 or 4 inches in width.

DISTANCES TO PLANT AND QUANTITY OF SEED REQUIRED

The distance between the rows ranges from 7 to 14 inches, but varies with the method of sowing. The larger yields are obtained

FIGURE 4.—Special tools for planting and cultivating onion sets

by sowing in single drills about 9 inches between the rows and using 65 to 85 pounds of seed to the acre. Most growers endeavor to sow their onion seed as early as the land can be put in first-class condition. Formerly the seeds for sets were not sown until late in the season, but it has been found that larger yields of sets can be obtained and that the sets will ripen better if the seed is sown early.

The New Jersey growers have found it more profitable to grow a sort of mixed crop, including all sizes from sets to marketable onions. A smaller quantity of seed is employed per acre, but, on the other hand, the method of growing is somewhat different, and a larger percentage of overgrown bulbs is secured. Those that are below standard size are sold as "boilers" or "stewers," "picklers," and "sets." By using about 25 pounds of first-class seed to the acre and planting in rows 24 inches apart these growers are enabled to employ horse culture and succeed in growing about 300 bushels of all sizes

to the acre. This method of planting does not greatly decrease the yield and at the same time reduces the cost of cultivation.

CULTIVATION

As a rule the onion seed will germinate and the plants appear above ground so that the rows can be followed within six to eight days after planting. It is desirable that the soil should be stirred frequently and that the weeds should never be given an opportunity to gain a foothold. The onion sets should be cultivated at least once every week during their growing period.

The tools employed are for the most part of the wheel-hoe type, of which there are a number of forms. These tools are provided with numerous attachments for cutting close to the plants, for throwing the soil away from the rows, and for leveling and working it back around them. Some of the Chicago growers have adopted a special wheel hoe of their own design, using the front wheel of a bicycle and a pair of lightweight plow handles for the frame, to which the various types of sweeps and shovels are attached. In New Jersey horse tools are employed almost exclusively, the 14 or 15 tooth harrow-type cultivator (fig. 5) being the favorite.

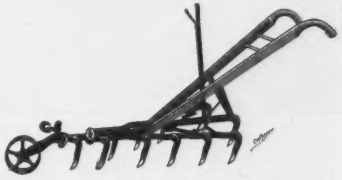

FIGURE 5.—One-horse cultivator of the harrow type

Hand weeding seems to be essential in all localities, although this laborious process can be eliminated to some extent by proper wheel-hoe and horse cultivation. The cost of the cultivation of an acre of onion sets during the season should not exceed $100, and this may be reduced considerably if the land is in proper condition and the work done at the right time. Hand weeding in most cases will be necessary twice during the growth of the crop. During rainy seasons it is often found impossible to keep certain areas clean, and when the weeds once become well established there is very little hope of saving the crop.

When the sets have attained considerable growth the tops shade the ground and prevent, in a measure, the growth of weeds. After this stage has been reached very little attention will be required. In fact, the stirring of the soil should cease before the sets show any tendency to ripen. Figure 6 will give some idea of the appearance of an onion-set field at the period of its maximum development.

HARVESTING AND CURING

The time for harvesting is just when the sets begin to ripen. This generally occurs about July 4 in southern localities and July 20 near Chicago, or 90 to 110 days from the date of sowing the seed. The methods of harvesting are different in the several localities. Near Louisville, Ky., the sets are allowed to become quite ripe before harvesting.

At harvest time the sets are loosened from the soil by means of a cutter attached to a wheel hoe or with broad forks having 10 or 12 tines. They are then pulled by hand, as shown in Figure 7, the tops

FIGURE 6.—Hand weeding an onion-set field during early summer

FIGURE 7.—Harvesting onion sets near Louisville, Ky.

twisted off by hand, and the bulbs sifted and placed upon trays to dry. These trays are piled one upon another in the field (fig. 8) with a space of 3 or 4 inches between and a temporary roof placed over them. They are allowed to remain upon these trays until quite dry and are again screened and removed to the storehouse.

In some sections the sets are pulled while yet quite green and are stacked in the field in long, narrow ridges (figs. 9 and 10), the bulbs being placed underneath so that the tops will protect them from sunlight and rain. After remaining in these ridges about two weeks, the tops are twisted off and the bulbs placed upon screens to dry. From the screens they are hauled to the warehouse, where the fanning and cleaning take place.

Near Chicago the practice of pulling is very similar to that in the vicinity of Louisville, the tops being twisted off as the sets are removed from the soil. In New Jersey the sets are allowed to become fully ripe before being removed from the soil and are har-

FIGURE 8.—Onion sets drying on trays piled in a field

vested and cured together with the larger bulbs, after which they are separated by fanning and screening.

After pulling, it is essential that the sets be subjected to a drying process; during this process they require plenty of ventilation. This can be most easily secured by spreading the sets on trays, commonly called crates, that are provided with corner pieces extending 4 or 5 inches above the sides of the trays. As a rule these trays are constructed with 3-inch sides, about 5 feet square, with slat or wire bottoms, and hold about 3 bushels of onion sets. When the trays are piled one upon another the corner pieces provide an air space above each tray, thus securing the best possible ventilation. In the absence of corner pieces blocks of wood or broken bricks are employed, as shown in Figure 8. A roof of boards is placed over each stack of trays to protect the onion sets from the sun and rain.

Curing onion sets at a temperature of 100° F. with fan ventilation has proved quite successful in the Chicago district. The trays con-

FIGURE 9.—"Stacking" onion sets to cure in a field

FIGURE 10.—Onion sets curing in "stacks"

taining the onion sets are stacked over a long, narrow trench or tunnel in which there are coils of steam pipe heated from a steam boiler. The stack of trays is then inclosed by setting up sectional board sides which extend a few inches above the stack of trays. The heat is turned on and air is driven through the tunnel by means of a fan. By this method the heated air is driven upward all through the onion sets and they are thoroughly cured in about six hours.

STORING ONION SETS

The method of storage is essentially the same in all localities, the tray previously described being most commonly used. (Fig. 11.) When the sets have become sufficiently dry some growers transfer

FIGURE 11.—Onion sets stored on trays in a warehouse

them to the 1-bushel crates, in which they are shipped. Onion sets are stored under conditions similar to those required for large onions, the essentials being plenty of ventilation, dryness, and a comparatively low temperature. Slight freezing will not destroy them, provided they are not disturbed while frozen. However, freezing is always injurious and has a tendency to cause them to sprout earlier in the spring. If a uniform temperature 8 or 10 degrees above freezing can be maintained, it is more satisfactory than too frequent variation.

In Wisconsin onion sets are being successfully stored in a building heated to approximately 70° F. by means of a pipeless furnace placed underneath the onion storage room. The room itself is well insulated but is provided with plenty of windows and ventilators that are kept open during the curing process.

Some growers employ a form of open shed as a temporary storage place for the sets during the autumn months or until cold weather begins. A few growers store their crop until late winter and sell direct to seedsmen and dealers, but the majority turn their sets over to warehousemen for storage and disposal. Throughout the storage period the sets should be handled as little as possible and should be kept spread out thinly, so there will be no chance of heating. Onions in storage are constantly giving off more or less moisture and are liable to become damp and sprout if stored in too great bulk.

In preparing the sets for market they are first passed through a fanning mill, which removes all loose skins, earth, or shriveled bulbs, and then over a screen which removes any bulbs that are too large for the market demands. After this they are shipped in 1-bushel crates, bushel baskets, burlap bags, or barrels.

The crate is perhaps most desirable as a shipping package, as it protects the bulbs and allows free circulation of air. When shipped in bags the sets are liable to become injured, except where they are handled in carload lots. Tight barrels are objectionable unless the sets are thoroughly cured, as there is liability to heat in the center.

SIZES AND KINDS OF ONION SETS

The ideal onion set is almost globular in shape and a trifle less than half an inch in diameter. The illustration on the title-page shows a quart of first-class onion sets. The color should be bright and the surface free from smut or spots of any kind.

The term "pickler" is applied to the onion just above sets in size, or, in other words, one-half to three-fourths of an inch in diameter. The term "boiler" or "stewer" is applied to the size next larger than picklers, or from three-fourths of an inch to 1¼ inches in diameter, which are too small for sale as standard onions.

Sets larger than a half inch in diameter have a tendency to shoot the seed when planted.

In addition to the sets grown from seed there are a number of varieties of onions sold as sets that are grown without seed. These may be described as follows:

FALL TOP SETS

Fall top sets sometimes are called Egyptian or Catawissa onions. The plants send up seed stalks which often carry a few blossoms and may produce a few viable seeds, but which grow sets in place of blossoms. These bulblets are planted in the fall for early spring bunching. The old plants are also split extensively at the base, so that they are never used for the production of "dry bulbs."

SPRING TOP SETS

Spring top sets also produce sets at the top of the blossom stalks, but the sets, which are carried over winter and planted, make large firm dry bulbs, which when planted the following year send up seed stalks and produce a crop of top sets. This type of top set is not offered by dealers as frequently as formerly.

MULTIPLIER ONIONS

Multiplier onions make no top sets and rarely produce seeds. There are a number of types. The true multipliers are:

(1) English, yellow multipliers or potato onions are grown to some extent locally from Maryland south. They never send up seed stalks, but large bulbs will produce a group of small bulblets or sets. These, when planted in spring, will produce large firm dry bulbs that are of fair keeping quality.

(2) White multipliers, the bulbs of which rarely send up seed stalks, but from each one a group of bulbs a little larger than pickling onions is harvested. The onion is largely shipped from Louisiana during late winter to the North as bunching onions.

(3) Shallots, not the true shallot, but should be called the Jersey shallot. It sends up seed stems and may make a few seeds, but the main energy of the plant goes into the production of numerous small bulbs at the base. It is extensively used in England and on the Continent as a seasoning onion. Jersey shallots are most often sold in the United States under the name of "multipliers" and may be yellow or red in color.

VARIETIES OF ONIONS USED FOR SETS

Seed of almost any variety of onion may be used for the production of sets, but a greater demand exists for the distinctly yellow, white, and red colors. In the trade the sets are recognized by their color rather than by actual varietal names. The demand for the yellow and the white sets is greater than for the red, and those of the globular type are preferred. Onion sets are sometimes grown from left-over seed, in which case a large number of varieties may be included.

Southern-grown onion plants are now supplanting onion sets to a considerable degree, especially for starting early onions grown in home and market gardens. These plants, which are grown mainly in the Gulf Coast States and in southwestern Texas, are crated and shipped in great quantities to northern dealers and gardeners. There appears, however, to be little difference in the cost of the seedling plants as compared with sets, especially for small plantings.

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May 14, 1930

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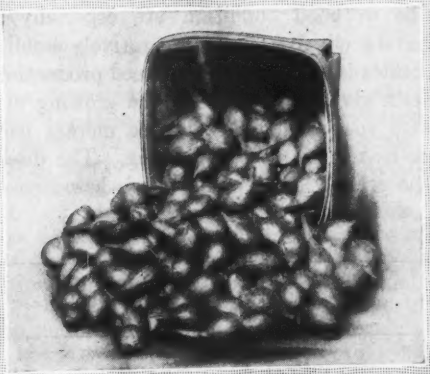
The HOME PRODUCTION OF ONION SEED AND SETS



UNITED STATES DEPARTMENT OF AGRICULTURE

THE GREATER PART of the onion seed used in this country is produced by western seed growers who are specialists in seed production. Some onion growers, however, produce their own supply of seed from strains which they have developed for special adaptation to local conditions.

The production of seed of high-quality stocks and strains of onions involves numerous problems and difficulties. Special knowledge of the varieties to be grown and of effective practical plant-breeding methods is required. Suitable parent stock and some special facilities for handling the breeding material must be available. Proper storage facilities for keeping the mother bulbs in good condition are especially important. Furthermore, the climate of a comparatively small portion of the United States is adapted to onion-seed production.

This bulletin gives directions for the growing of both seed and sets, with special reference to the market gardener and truck farmer as relates to seed growing. The discussion pertaining to the production of onion sets is based on commercial production.

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THE HOME PRODUCTION OF ONION SEED AND SETS[1]

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INTRODUCTION

Some of the leading onion growers are raising their own supplies of seed; by so doing they can produce stocks that are better adapted to their particular requirements than are the supplies generally available on the market. It must be recognized, however, that in recent years there has been a marked improvement in quality of seed stocks obtainable through the ordinary channels of trade. Unless a careful and thorough search for satisfactory stocks has proved to the grower that he cannot buy seed that is satisfactory under his particular conditions, it is doubtful whether the home production of seed is justified.

Seed production on the part of the individual onion grower, although advantageous in certain instances, has its limitations, difficulties, and disadvantages. Comparatively few large areas of the United States have a climate that is well adapted to onion-seed growing. First, the weather should be dry during the curing of mother bulbs. The climate should be rather cool and moist during a fairly long part of the early season, or nearly up to the time of the flowering of the onion, then warm and fairly dry, with infrequent rains. The period of seed curing should, of course, be dry. Certain irrigated areas of the Pacific Coast and Mountain States best meet these requirements, although seed is grown with a fair degree of success in some of the Northern and Eastern States.

If superior stocks are to be developed, or even maintained after they have been developed or obtained elsewhere, the seed grower must have a few important plant-breeding principles well in mind

[1] For culture of onions for the general market, see Farmers' Bulletin 354, Onion Culture.

and must have adequate facilities for making selections, controlling pollination, growing and studying selections, storing mother bulbs, and handling small as well as large lots of seed. The equipment need not be elaborate, but numerous precautions must be observed.

The grower must have accurate knowledge of the shape, outer scale and inner flesh color, time of maturity, and size of the variety he is to grow. Carelessness in this respect may result in the production of a stock that suits no one but the grower. Careful attention to the requirements of the markets and of other growers is quite important, for a multiplicity of strain differences within a variety generally leads to dissatisfaction and confusion.

Some growers plant for seed only when they have failed to sell their bulb crop. This practice should be strongly discouraged because bulbs grown for market instead of for seed production are almost always inferior in uniformity or in other respects to the carefully handled stocks produced especially for seed. There is no longer any place for poor seed stocks.

Onion-seed growing is a 2-year process, and the two crops must constantly be cared for. After the bulbs are grown the first summer they must be stored over winter and replanted the following spring for the production of seed. Meantime the crop for the next year's planting must be coming on, in order to have a crop of seed every year.

The production of onion sets has been confined to a few localities. Sets may be produced under a reasonably wide range of conditions; but, in order to be successful, the grower should fully understand the principles and methods involved. Although the production of onion seed and sets together constitute an important phase of the general onion industry, owing to the specialized nature of seed production and the production of sets, they are here discussed separately.

PRODUCTION OF ONION SEED

OLD METHODS

Most growers of onion seed attempt to improve the crop by the simple process of mass selection or selecting a limited quantity of excellent-appearing bulbs, or "mother bulbs" as they are commonly called, from the whole crop or field, and then growing these in a separate field or seed plot the following year. The seed so obtained is used for growing a crop of bulbs for market, and the finest bulbs are again selected from this crop to be used for seed production. Although it is true that progress has been made by this method, it must be recognized that progress is necessarily slow and that the greatest possibilities of the onion crop can hardly be developed by this means.

RELATION OF FLOWERING HABIT TO SEED PRODUCTION

Some of the flowers in the head of the flowering onion plant are fertilized by pollen from other flowers on the same plant, but under field conditions a large proportion of them are certainly fertilized by pollen from other onion plants. This large amount of natural crossing or cross-fertilization is accomplished chiefly by various kinds of insects. Some onion plants produce flowers that are almost completely self-sterile, which means that they will set very few, if any,

seeds unless suitable pollen is carried to them from other plants. On the other hand, there are plants that will produce fair yields of seed by their own pollen alone, when bags are placed over the flower heads to prevent pollen from other plants reaching the flowers.

Bearing in mind the frequency of crossing in the field, it can be readily understood why the method of selection described above is certain to be slow and only partly effective. Even though the grower selects only the most nearly ideal appearing bulbs for seed purposes, the chances are that they came from seed that was grown in a field where there was a chance for crossing with more or less offtype plants. If this did occur, plants grown from the seed produced by these fine-appearing mother bulbs will almost certainly show undesirable variations in shape, color, or other characters.

It may be argued that this is of little consequence, since the offtype bulbs can be eliminated and seed saved only from the ideal ones. On the contrary, some of these fine bulbs of the second selection may have developed from seed from flowers that were cross-fertilized with pollen carrying undesirable characters that were present in temporarily hidden form in the first selected lot of mother bulbs. Thus it will be evident that as long as free cross-pollination is permitted among plants that are visibly mixed or that have a mixed hereditary make-up only slow progress can be made. In fact, there are certain undesirable characteristics among many stocks of onions that probably cannot be eliminated by this old mode of procedure.

NEW METHODS

SELECTION AND CARE OF BULBS FOR SEED

Before attempting to grow a seed crop or to effect any improvement in a variety, care should be exercised to obtain the most uniform and nearly ideal stock or strain of the desired variety which can be obtained. A number of commercial seedsmen have developed stocks and strains distinctly better than were available a few years ago. A few of the State agricultural experiment stations, particularly in the regions where onions are most extensively grown, have developed improved varieties and strains.

The bulbs for the production of onion seed should be grown in the same manner as those intended for marketing, except that more care should be taken throughout. Some seed growers prefer to use 6 pounds of seed to an acre for the production of seed bulbs instead of 4 pounds, as ordinarily used in growing for market, in order that the bulbs may crowd and not become too large. The planting, culture, and harvesting of the bulbs are practically the same as for first-class market stock.

In selecting the bulbs to be grown for seed only those that conform to the ideal for the variety should be chosen. Great care should be exercised in this respect, lest an unsatisfactory type be developed. In the beginning, only a few hundred bulbs need be selected, for they are to serve not as mother bulbs for a seed crop for planting or for sale but only as a starting point from which such a supply is to be developed.

CARE OF BULBS DURING THE WINTER

Bulbs to be used for seed production should be allowed to become thoroughly ripe in the field. After being pulled, they should be stored in crates under a roof where they will have plenty of ventilation and be protected from sun and rain. Before freezing weather begins the onions should be graded and removed to a house where both ventilation and temperature can be controlled.

The temperature of the room in which the mother bulbs are stored should be kept as near 45° F. as possible. Experimental work done by the California Agricultural Experiment Station shows that storing mother bulbs at temperatures below 40° for any considerable period greatly reduces the production of seed heads and seeds. A storage temperature of about 43° to 48° results in the highest yield of seed. If the storage temperature is allowed to go above 50° for more than a few days there may be considerable loss from sprouting. The storage room should be well ventilated, since high humidity is conducive to the development of disease.

PURIFYING STOCK BY SELF-POLLINATION

The California Agricultural Experiment Station has conducted the most intensive and productive work upon breeding and improvement of onions that has been done in this country. The results of that work indicate a more rapid and more certain method of procedure that involves, briefly: (1) Purifying a stock by the self-pollination of successive crops or "generations" and rigidly selecting within these selfed or inbred lines; and (2) cross-pollinating numerous apparently identical "purified" lines from these self-pollinated selections, in the instance of varieties which show much loss of vigor and productivity as a result of self-pollination. This cross-pollination restores vigor and productivity. Good commercial stocks have been obtained in a number of instances by only a single generation of selfing, followed by selection and cross-pollination. Sometimes, however, the procedure must be continued into later generations.

The method of obtaining selfed seed is simple. Just before the first flower on a flower head opens, the entire head is enclosed in a 1- or 2-pound manila paper bag, preferably in a 1-pound bag if large enough. The smaller-sized bag results in less damage to the bag or plant from being blown about by the wind. The mouth of the bag is tied securely about the seedstalk, below the flower head, to keep foreign pollen and insects out, and to prevent the loss of seeds by shattering.

From the beginning of the flowering period, the plants must be gone over twice daily and bags applied as the flowers of additional flower heads are about to open. This procedure should be continued until the desired number of plants have been bagged. Also, twice daily the bagged heads should be tapped vigorously with the hand, to insure the distribution of pollen within the bag. This should be done for about 2 weeks. The bagged heads will be ready to harvest in about 2 months. The stalks may be cut just below the bags and the heads left in them until they are threshed. The heads should be thoroughly dried by placing the bags on trays or canvas in the sun, kept dry at all times, and threshed as soon as the seed is dry.

The seed heads are threshed, and the seed from each plant is kept separate, so it can be later sown in a part of a row to itself and handled as a distinct lot.

Bulbs are grown from these selfed seeds, the lot from each plant being kept separate. These bulbs are rigidly selected for conformity to type, the selections are planted as mother bulbs, and the self-pollination procedure is repeated. Further selection and selfing is carried on until highly uniform lines having the desired qualities have been obtained. It is desirable to carry along 15 to 20 apparently identical but separate selections developed from as many original selections if they can be obtained, so that they may be cross-pollinated among themselves to restore vigor, in case there is a marked loss of vigor as a result of repeated self-pollination.

If loss of vigor is not serious, the inbred lines may be increased for commercial planting or seed production. The increase plot should, of course, be isolated from other flowering onion plants.

RESTORATION OF VIGOR IN INBRED SELECTIONS

The workers at the California Agricultural Experiment Station have shown that some varieties, such as Australian Brown, lose vigor rapidly with repeated self-pollination, while others, such as Italian Red, suffer but little loss in productivity. In order to restore vigor, bulbs of several practically identical inbred selections may be mixed and planted as a single lot of mother bulbs, to be allowed to cross-pollinate freely in the open. Open-pollinated seed from such a mixed lot has been shown to be of normal vigor.

It is important to remember that the selfed lines that are to be mixed together for cross-pollination must each have been developed from a different original mother bulb. Crossing sister lines (two or more lines descended from a single original mother-bulb selection) does not usually result in the desired restoration of vigor. Precautions must be taken, of course, to isolate this open-pollinated plot from any other flowering onions, lest they become crossed with undesirable forms.

SOILS ADAPTED TO THE GROWING OF SEED

Two types of soil may be used to advantage in growing onion seed. The soil upon which the bulbs are grown from seed should be quite rich and well supplied with organic matter and moisture. Good rich sandy loam is best adapted to the growing of the bulbs. For the production of seed from bulbs, a soil that is well drained, fertile, and of a loamy nature is desirable. It is customary to grow the bulbs the first season on rich bottom land and the second season to grow the seed on well-drained upland. Soils containing an abundance of lime, such as are suited to the successful production of wheat, are adapted to onion-seed growing. The soil should be free from weed seeds and in a good state of tilth.

The bulbs for seed growing should not be set in a soil containing large quantities of fresh stable manure or green vegetable matter, but commercial fertilizers containing a small percentage of nitrogen, 6 to 8 percent of available phosphoric acid, and 6 to 8 percent of potash can be used to advantage at a rate not exceeding 1,000 pounds to the acre. The bulbs should be planted on land on which a cultivated crop was

grown the previous season and on land on which weeds and grass will be under control.

PREPARING THE SOIL AND PLANTING THE BULBS

In preparing the land for setting the bulbs, apply the fertilizer and reduce the soil to a good state of tilth. Then mark off the land in rows about 2½ to 3½ feet apart by means of a one-horse plow, a corn marker, or some tool that will leave a decided furrow in which to set the bulbs. In some sections the rows are placed as close as 2 feet, but this hinders cultivation.

The bulbs should be placed by hand (fig. 1), root downward, from 3 to 6 inches apart, center to center, in the furrow. The usual rule is to set the bulbs so that the distance between them will be about 4 inches.

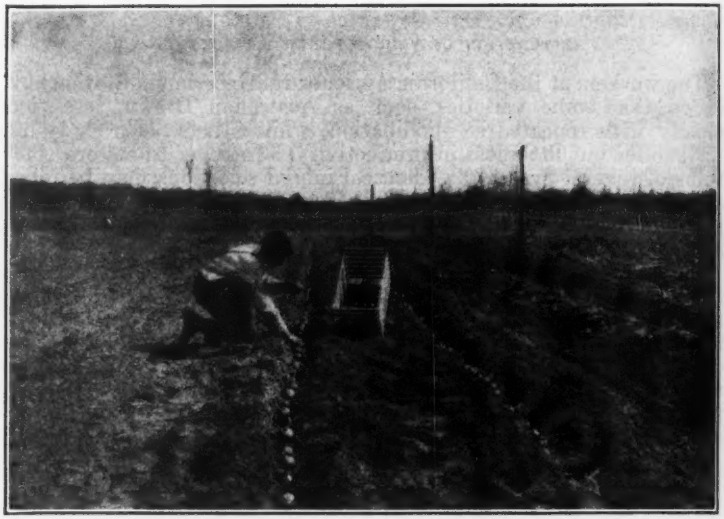

FIGURE 1.—Method of setting out bulbs for seed production.

The quantity of bulbs that may be set on an acre will depend largely upon their size, but may be as high as 250 bushels. Where the seed is to be employed for growing sets and overgrown sets are used as mother bulbs, the quantity required may be as low as 50 bushels to the acre.

The bulbs should be placed in the ground sufficiently deep to be entirely below the surface of the soil when covered. As growth proceeds the soil should be drawn around the bulbs to form a support for the seedstalks.

CULTIVATION

Shallow cultivation should be given throughout, the object being to keep the land free from weeds and the soil worked toward the plants. Very little handwork will be necessary, except, perhaps, going through after the seed heads have formed, removing the weeds,

and drawing the soil around the plants to hold the stalks erect and prevent the seed heads from blowing down and coming in contact with the soil.

TIME AND MANNER OF GATHERING THE SEED

The proper time to gather the seed is when the inside of the grain has reached the dough stage. Onion seed assumes its black color very early; in fact, before it has passed the watery stage and formed milk in the grain. This change of color is no indication of ripeness and very often deceives the inexperienced grower. The heads should be harvested just before the first-formed seed begins to shatter in handling. Two or three cuttings of the seed should be made, about 20 percent of the heads being removed at the first cutting.

FIGURE 2.—Field of onion seed a short time before harvest.

Figure 2 shows a field of onions a short time before the seed is ripe. In harvesting, the heads are cut one at a time by hand, with a very short piece of the stem attached, and are placed in bags for transportation to the curing sheds.

CURING THE SEED HEADS

Any building which has a tight floor and in which a free circulation of air can be maintained will serve as a curing place for onion seed. Many growers employ buildings similar to those used for curing tobacco, with the alternate vertical siding boards hinged so that they can be thrown open during good weather. In localities where rains do not occur during the curing period the seed heads are frequently dried on sheets of canvas stretched over frames or spread upon the ground.

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For curing the seed in houses, wire-bottomed racks or trays placed one above the other are generally employed. As the seed is stirred from time to time during the curing process a considerable portion of it will be shattered and will fall upon the tray below or finally upon the floor. The main essentials in the curing of onion seed are to spread the heads very thinly, not over two heads in depth, and to give free ventilation. Even at a depth of 3 inches in the trays it will be necessary to stir them very often, especially during damp weather.

THRESHING AND CLEANING THE SEED

The date for gathering the seed depends upon the locality and climate, but as a rule this will be about midsummer or not later than August 15. The threshing and cleaning of the seed are often deferred until quite late in the autumn, except where the curing is done in the open air. Where large quantities of seed are produced the threshing is done with special machines, but when grown on a small scale the seed is beaten out with a flail.

After the seed has been threshed or beaten from the heads there is still considerable danger of its heating or molding if left in too great bulk. The usual practice is to run it through a fanning mill to remove the dust and the small particles of stems, heads, or chaff that are broken up in the threshing. The special threshing machines have a fanning attachment which removes most of the trash.

In California, where a large part of the supply of onion seed is grown, the seed is washed immediately after being threshed and is then spread on canvas sheets to dry. In washing, the seed is poured slowly from the bags into a trough of water, the heavy seed settling to the bottom and the lighter seed and the chaff rising to the surface. The seed is then thoroughly stirred so as to permit all of the lighter seed to float. The lighter materials are floated off, and the heavier seed is lifted out immediately and spread out to dry. It is important that the seed should not be allowed to remain in the water more than 30 minutes, and on being taken from the water it should be spread thinly on wire-bottom trays or on canvas to dry. The seed should never be washed on a damp day or late in the day, as it must be partially dry before nightfall. On the day after it has been washed, the seed should be frequently stirred with the hands, a board, or a wooden rake. Although the seed may appear to be perfectly clean after it is dried, there is always some light or shriveled seed present, and it is necessary to put the seed through the fanning mill once more, or possibly twice, to get out all the inferior seed.

In sections where the seed cannot be dried quickly it is not safe to wash it; it should be cleaned entirely by means of cleaning machinery. It is not safe to bag the seed and store it unless it is thoroughly dry.

YIELD OF SEED TO AN ACRE

The quantity of onion seed that can be grown on an acre depends on several conditions. In the first place, this will be determined largely by the size of the bulbs that are planted. In the onion-set districts, where the seed with which to produce the sets is locally grown from overgrown sets, the quantity of seed is generally from 6 to 8 pounds to the bushel of bulbs planted. This seed, however, is not suitable for the production of standard market onions and can be

used only for set growing. In the production of seed from standard mother bulbs the yield is generally from 2 to 3 pounds of seed for every bushel of bulbs planted. The yield has been much higher in many cases, but 2½ pounds is generally considered satisfactory. The yield of seed as a rule will be about 400 pounds to the acre, although as much as 800 or even 1,000 pounds has been secured. White varieties produce a smaller quantity of seed than the brown and yellow varieties.

The price per pound paid for the seed varies according to the quality, variety, and market demands. For first-class high-grade seed from specially selected bulbs of desirable types the growers frequently receive two or three times as much per pound as for the general crops produced from bulbs not specially selected, which must be sold in competition with the great mass of seed produced by large growers.

When the cost of growing the bulbs, together with the preparation of the land, the keeping of the bulbs over winter, the necessity of handling them a great many times, and the occupying of the land for two seasons are considered, it will be readily seen that there is not a great profit in growing onion seed. However, there are many farmers who each year plant 2 or 3 acres to bulbs for seed and have for sale anywhere from 1,000 to 1,500 pounds of very choice seed. In many cases this represents the money crop of the farm.

The extent to which this enterprise can be conducted with profit is doubtless limited, but the demand for high-grade seed of a distinct type is increasing each year. Anyone contemplating the growing of onion seed should carefully study local conditions and then operate in a small way until the necessary practices are thoroughly understood.

PRODUCTION OF SEED FOR ONION-SET GROWING

Occasionally the seed for onion-set growing is produced from bulbs selected from the sets themselves; in other words, the mother bulbs are the overgrown sets. Near Louisville, Ky., the onion-set growers select the oversized bulbs and store them over winter. In the spring they send them to farmers in the hill country and have their supply of seed grown on bluegrass land which has not been heavily manured. In this way they are able to keep their onion seed free from disease and to obtain a higher vitality than if the seed were grown on the land on which the bulbs were produced.

Owing to the great quantity of seed employed in set growing, it is desirable to secure it cheaply, and the bulbs selected from the sets, being small, will produce a larger quantity of seed per bushel from mother bulbs than when grown in the usual manner. The stock seed bulbs should, however, be well matured, small necked, uniform in size, and selected according to an ideal shape. Onion seed from unselected bulbs is not desirable for set growing, and it is doubtful if anything but high-grade seed from selected bulbs should be used in growing sets.

After a crop of onion seed has been gathered it is the usual custom to plow up the bulbs and devote the land to some other crop. If the old bulbs are allowed to remain in the soil through the winter, especially if given slight protection, they will produce a small crop of seed the second season. This practice is not recommended except

under special conditions where the land is not valuable or where it is particularly desirable to obtain an additional quantity of seed from the bulbs.

CARE OF ONION SEED

The length of time that onion seed will retain its vitality depends largely upon maturity and climatic conditions. Well-matured seed will always keep better than poorly ripened and inferior seed. Under ordinary conditions onion seed loses its vitality very rapidly after the second year, especially if stored in a damp climate. It will often pay to ship the seed to a dry climate for storage.

PRODUCTION OF ONION SETS

CLIMATE AND SOILS ADAPTED TO ONION-SET GROWING

The term "set", as applied to the onion, indicates a small, undersized bulb which, when replanted in the ground, will produce a large onion. This method of producing onions is perhaps the oldest and now the most universally employed for the growing of small areas of onions in the garden and where an early crop is desired. The common method of producing sets is to plant a large quantity of seed on a small area of fairly rich land and thus produce a great number of bulbs that are undersized, owing to crowding and lack of plant food. The greater number of these bulbs do not attain sufficient size or maturity to produce seed the following season and are really plants in which the process of growth has been arrested.

In the United States the onion-set industry is largely confined to a few areas. The crop is extensively grown near Louisville, Ky., Chicago, Ill., in the Platte River Valley of Nebraska, in southwestern New Jersey, and in southern California. The entire area devoted to this enterprise in these localities is estimated at from 2,500 to 3,000 acres. The yield to the acre varies with the locality, but will average about 300 bushels. The market for onion sets is found throughout the entire country, the greater portion being disposed of in small quantities.

The climatic conditions governing the production of onion sets are practically the same as those for standard onions, although it is not necessary to plant quite so early in the spring. Onion sets can undoubtedly be grown in any part of the Northern States where suitable soil conditions can be obtained. The soil adapted to onion-set culture is as a rule about the same as that required for the growing of large onions, except that the land should not be so rich.

In the Louisville district the soil is a clay loam containing plenty of lime. This soil, if fertilized, will yield 250 to 350 bushels of mature onions and will produce an equal quantity of sets, but the fertilizer requirements for the latter are not so great. This land is underlain by limestone at a depth varying from 18 inches to 10 or 12 feet and is a natural bluegrass soil, retentive of moisture and comparatively free from weeds.

In the Chicago area there is a variation in soil texture. In the vicinity of South Chicago the area devoted to onion-set growing was formerly a sewage-disposal farm and is laid off in regular level beds. This soil is of a sandy, loamy nature and is very similar to river-bottom lands. Northwest of Chicago and near Racine, Wis.,

the soil is a more gravelly loam, although in some places it is of a river-bottom or silty nature.

In southwestern New Jersey the soil is a sandy loam, not unlike the Norfolk sandy loam, although it contains more or less gravel, and in places the clay approaches the surface.

It will be seen that onion sets can be grown on any land that is adapted to general truck crops, the main essential being freedom from weeds and a reasonably high state of tillage.

PREPARATION OF THE SOIL

The land for onion-set growing should be prepared in practically the same manner as for regular crops of onions. The plowing need be only moderately deep, but the soil must be brought to a smooth, fine surface, suitable for the proper sowing of the seed by means of hand drills. The tools generally employed for this purpose are the plow, disk harrow, roller, smoothing harrow, and sometimes a pull or drag made of scantlings or planks. A harrow of the type shown in figure 3 is adapted to the final preparation of the soil before the seed is planted.

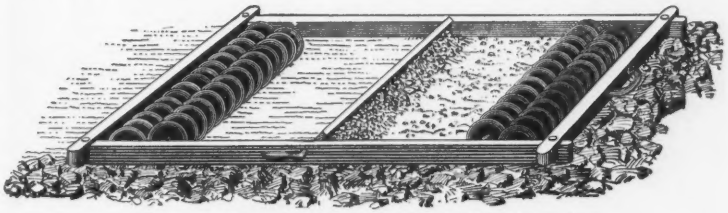

FIGURE 3.—Harrow for leveling soil before planting onion seed.

On some land onion sets have been grown continuously year after year without any appreciably injurious results. In other localities it has been found necessary to adopt a crop-rotation system. This is advisable wherever the quantity of available land is sufficient. A rotation including corn, potatoes, onion sets, and clover will be found quite satisfactory.

FERTILIZERS

In preparing the land for growing onion sets large quantities of barnyard manure should not be applied immediately before planting. If barnyard manure is to be employed, it should be used the previous season on some other crop, in order that it may become fully incorporated with the soil and somewhat reduced in intensity.

Commercial fertilizers may be employed profitably in moderate quantities, say 600 to 1,200 pounds to the acre, and should be broadcast at the time of fitting the land. This fertilizer should contain about 4 to 5 percent of nitrogen, 8 to 10 percent of available phosphoric acid, and 6 to 8 percent of potash.

SOWING THE SEED

As the essential feature of growing onion sets is the crowding together of the plants in rows, a large quantity of seed is required

to plant an acre. The quantity of seed required varies with the different localities. In the vicinity of Louisville, Ky., from 55 to 60 pounds to the acre is sown; Colorado, 100 pounds; Chicago, 55 to 120 pounds; while in New Jersey as little as 25 pounds to the acre is used.

As a rule, the drills employed for seeding are the hand seeders usually found on the market, which are used in sowing the seed of all small truck crops. In some localities, however, special seeders have been designed, in order to distribute the seed in a particular manner (fig. 4). These seeders distribute the seed in five little drills about an inch apart, making a broad belt of five rows. Another method is to place a funnel-shaped spreader on the under part of the drill, which scatters the seed over an area 3 or 4 inches in width.

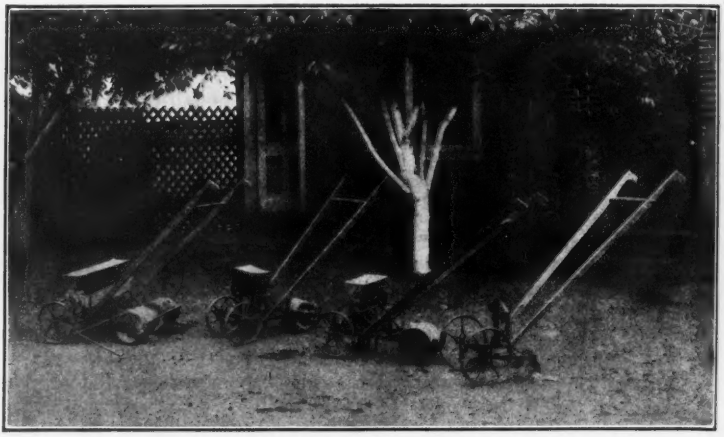

FIGURE 4.—Special tools for planting and cultivating onion sets.

PLANTING DISTANCES AND THE QUANTITY OF SEED REQUIRED

The distance between the rows ranges from 7 to 14 inches, but varies with the method of sowing. The larger yields are obtained by sowing in single drills about 9 inches between the rows and using 65 to 85 pounds of seed to the acre. Most growers endeavor to sow their onion seed as early as the land can be put in first-class condition. Formerly the seeds for sets were not sown until late in the season, but it has been found that larger yields of sets can be obtained and that the sets will ripen better if the seed is sown early.

The New Jersey growers have found it more profitable to grow a sort of mixed crop, including all sizes from sets to marketable onions. A smaller quantity of seed is employed per acre, but, on the other hand, the method of growing is somewhat different, and a larger percentage of overgrown bulbs is secured. Those that are below standard size are sold as "boilers" or "stewers", "picklers", and "sets." By using about 25 pounds of first-class seed to the acre and planting in rows 24 inches apart these growers are able to employ horse culture and can grow about 300 bushels of all sizes to the acre. This method of planting does not greatly decrease the yield and yet it reduces the cost of cultivation.

CULTIVATION

As a rule the onion seed will germinate and the plants appear above ground so that the rows can be followed within 6 to 8 days after planting. It is desirable that the soil should be stirred frequently and that the weeds should never be given an opportunity to gain a foothold. The onion sets should be cultivated at least once every week during their growing period.

The tools employed are for the most part of the wheel-hoe type, of which there are a number of forms. These tools are provided with numerous attachments for cutting close to the plants, for throwing the soil away from the rows, and for leveling and working it back around them. Some of the Chicago growers have adopted a special wheel hoe of their own design, using the front wheel of a bicycle and a pair of lightweight plow handles for the frame, to which the various types of sweeps and shovels are attached. In New Jersey horse tools are employed almost exclusively, the 14- or 15-tooth harrow-type cultivator (fig. 5) being the favorite.

Hand weeding seems to be essential in all localities, although this laborious process can be eliminated to some extent by proper wheel-hoe and horse cultivation. The cost of the cultivation of an acre of onion sets during the season should not exceed $100, and this may be reduced considerably if the land is in proper condition and the work done at the right time. Hand weeding in most cases will be necessary twice during the growth of the crop. During rainy seasons it is often found impossible to keep certain areas clean, and when the weeds once become well established there is very little hope of saving the crop.

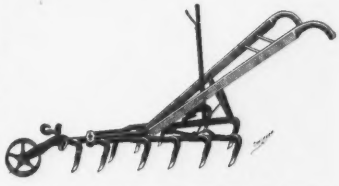

FIGURE 5.—One-horse cultivator of the harrow type

When the sets have attained considerable growth the tops shade the ground and prevent, in a measure, the growth of weeds. After this stage has been reached very little attention will be required. In fact, the stirring of the soil should cease before the sets show any tendency to ripen. Figure 6 will give some idea of the appearance of an onion-set field at the period of its maximum development.

HARVESTING AND CURING

The time for harvesting is just when the sets begin to ripen. This generally occurs about July 4 in southern localities and about July 20 near Chicago, or 90 to 110 days from the date of sowing the seed. The methods of harvesting are different in the several localities. Near Louisville, Ky., the sets are allowed to become quite ripe before they are harvested.

At harvest time the sets are loosened from the soil by means of a cutter attached to a wheel hoe or with broad forks having 10 or 12 tines. They are then pulled by hand, as shown in figure 7, the tops twisted off by hand, and the bulbs sifted and placed upon trays to dry. These trays are piled one upon another in the field (fig. 8) with a space of 3 or 4 inches between and a temporary roof over

them. They are allowed to remain upon these trays until quite dry, when they are again screened and removed to the storehouse.

In some sections the sets are pulled while yet quite green and stacked in the field in long, narrow ridges (figs. 9 and 10), the bulbs

FIGURE 6.—Hand weeding an onion-set field during early summer.

FIGURE 7.—Harvesting onion sets near Louisville, Ky.

being placed underneath so that the tops will protect them from sunlight and rain. After about 2 weeks, the tops are twisted off and the bulbs placed upon screens to dry. From the screens they are hauled to the warehouse, where they are fanned and cleaned.

Near Chicago the practice of pulling is very similar to that in the vicinity of Louisville, the tops being twisted off as the sets are removed from the soil. In New Jersey the sets are allowed to become fully ripe before being removed from the soil. They are harvested and

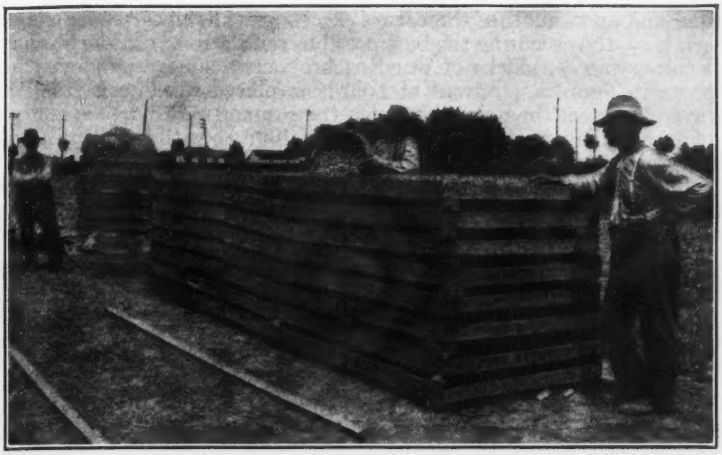

FIGURE 8.—Onion sets drying on trays piled in the field.

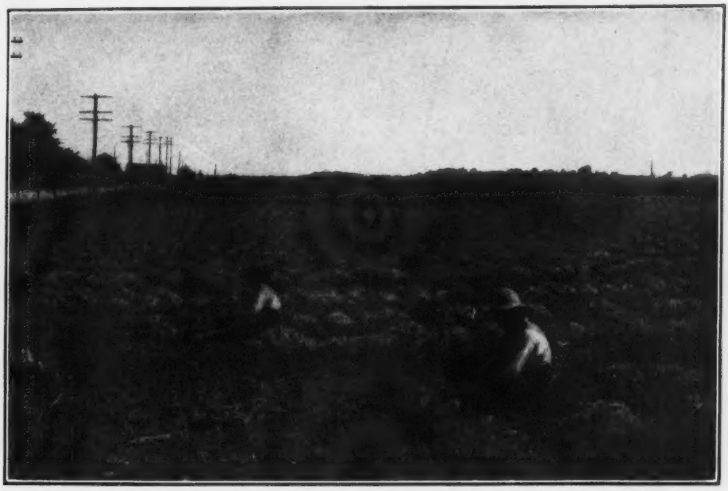

FIGURE 9.—Stacking onion sets in the field to cure.

cured together with the larger bulbs, after which they are separated by fanning and screening.

After pulling, it is essential that the sets be subjected to a drying process; during this process they require plenty of ventilation. This

can be most easily secured by spreading the sets on trays, commonly called crates, that are provided with corner pieces extending 4 or 5 inches above the sides of the trays. As a rule these trays are constructed with 3-inch sides, about 5 feet square, with slat or wire bottoms, and hold about 3 bushels of onion sets. When the trays are piled one upon another the corner pieces provide an air space above each tray, thus securing the best possible ventilation. In the absence of corner pieces, blocks of wood or broken bricks are employed, as shown in figure 8. A roof of boards is placed over each stack of trays to protect the onion sets from the sun and rain.

Curing onion sets at a temperature of 100° F. with fan ventilation has proved quite successful in the Chicago district. The trays containing the onion sets are stacked over a long, narrow trench or tunnel in which there are coils of steam pipe heated from a steam boiler. The stack of trays is then enclosed by setting up sectional

FIGURE 10.—Onion sets curing in windrows, commonly referred to as stacks.

board sides which extend a few inches above the stack of trays. The heat is turned on, and air is driven through the tunnel by means of a fan. By this method the heated air is driven upward all through the onion sets and they are thoroughly cured in about 6 hours.

STORING ONION SETS

The method of storage is essentially the same in all localities, the tray previously described being most commonly used (fig. 11). When the sets have become sufficiently dry some growers transfer them to the 1-bushel baskets or crates, in which they are shipped. Onion sets are stored under conditions similar to those required for large onions, the essentials being plenty of ventilation, dryness, and a comparatively low temperature. Slight freezing will not destroy them, provided they are not disturbed while frozen. However,

freezing is always injurious and has a tendency to cause them to sprout earlier in the spring.

In Wisconsin, onion sets are being successfully cured in a building heated to approximately 70° F. by means of a pipeless furnace placed underneath the onion-storage room. The room itself is well insulated but is provided with plenty of windows and ventilators that are kept open during the curing process.

Experiments conducted by workers in New York [2] indicate that a temperature between 30° and 32° F. is best adapted for the storage of onion sets and that sets stored within this range of temperature will give higher yields and produce a smaller number of seedstalks than those stored at any other temperature. These tests also show that if the sets are stored at 40° to 45° the yields are reduced and there is a marked increase in the percentage of seeders and double onions. The following paragraphs are taken from the report of these experiments.

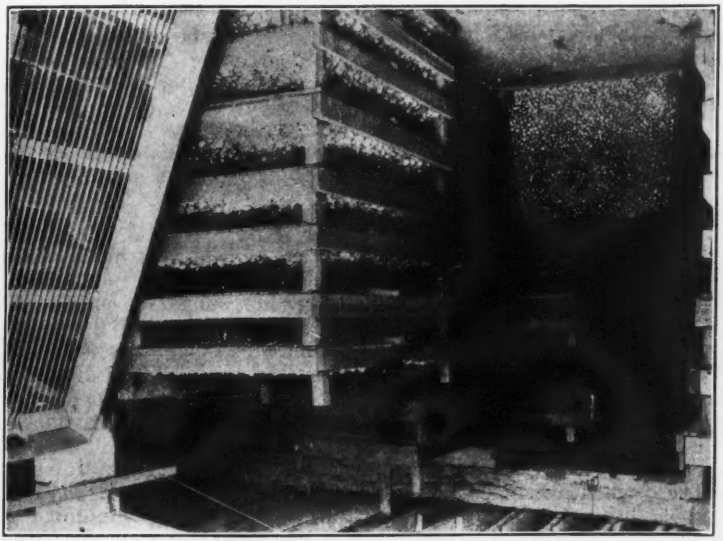

FIGURE 11.—Onion sets stored on trays in a warehouse.

The temperature under which the sets were stored had a marked effect on yield of marketable onions from all sizes of sets. In all cases the lowest temperature of storage (30° F.) was the best and the yield was reduced as the storage temperature was raised from 30° to 32° and from 32° to 40° F. The yield obtained from large sets stored at 50° F. was a little greater than those stored at 40° F. With medium and small sets the difference in yield between those stored at 40° and 50° is small and probably not significant. The sets kept in common storage, held between 60° and 70° F., produced a considerably larger yield than those held in cold storage at 40° or 50° F.

The temperature under which the sets are stored also affects the production of double onions, but this is complicated by the effect of temperature on subsequent development of the seedstalk. When seedstalks develop early the bulbs are less likely to split up than when the seedstalks develop late. When we consider only those sets that did not produce seedstalks, it is found that the percentage of

[2] Contribution No. 122 from the Department of Vegetable Crops, Cornell University, Proceedings of the American Society for Horticultural Science, 1934.

doubles is smaller from sets stored at 30° than from similar sets stored at 40° or 50° F. From this it appears that keeping the sets in a dormant condition during storage is desirable from the standpoint of reducing splitting, as well as for lessening seedstalk development and increasing yield.

Some growers employ a form of open shed as a temporary storage place for the sets during the autumn months or until cold weather begins. A few growers store their crop until late winter and sell direct to seedsmen and dealers, but the majority turn their sets over to warehousemen for storage and disposal. Throughout the storage period the sets should be handled as little as possible and should be kept spread out thinly, so there will be no chance of heating. Onions in storage are constantly giving off more or less moisture and are liable to become damp and sprout if stored in too great bulk.

Sets being prepared for market are first passed through a fanning mill, which removes all loose skins, earth, or shriveled bulbs, and then over a screen, which removes any bulbs that are too large for the market demands. After this they are shipped in 1-bushel crates, bushel baskets, burlap bags, or barrels.

The crate is perhaps most desirable as a shipping package, as it protects the bulbs and allows free circulation of air. When shipped in bags, the sets are liable to become injured, except where they are handled in carload lots. Tight barrels are objectionable unless the sets are thoroughly cured, as there is liability to heat in the center.

SIZES AND KINDS OF ONION SETS

The ideal onion set is almost globular in shape and a trifle less than half an inch in diameter. The illustration on the title page shows a quart of first-class onion sets. The color should be bright and the surface free from smut or spots of any kind.

The term "pickler" is applied to the onion just above sets in size, or, in other words, one-half to three-fourths of an inch in diameter. The term "boiler" or "stewer" is applied to the size next larger than picklers, or from three-fourths of an inch to 1¼ inches in diameter, which are too small for sale as standard onions.

Sets larger than a half inch in diameter have a tendency to shoot the seed when planted.

In addition to the sets grown from seed there are a number of varieties of onions sold as sets that are grown without seed. These may be described as follows:

FALL TOP SETS

Fall top sets sometimes are called Egyptian or Catawissa onions. The plants send up seed stalks which often carry a few blossoms and may produce a few viable seeds but grow sets in place of blossoms. These bulblets are planted in the fall for early spring bunching. The old plants are also split extensively at the base, so that they are never used for the production of "dry bulbs."

SPRING TOP SETS

Spring top sets also produce sets at the top of the blossom stalks, but the sets, which are carried over winter and planted, make large firm dry bulbs, which, when planted the following year, send up seed stalks and produce a crop of top sets. This type of top set is not offered by dealers as frequently as formerly.

MULTIPLIER ONIONS

Multiplier onions make no top sets and rarely produce seeds. There are a number of types. The true multipliers are:

(1) English, yellow multipliers, or potato onions are grown to some extent locally from Maryland south. They never send up seedstalks, but large bulbs will produce a group of small bulblets or sets. These, when planted in the spring, will produce large firm dry bulbs that are of fair keeping quality.

(2) White multipliers, the bulbs of which rarely send up seedstalks, but from each one a group of bulbs a little larger than pickling onions is harvested. These onions are largely shipped from Louisiana during late winter to the North as bunching onions.

(3) Shallots (not the true shallot, but should be called the Jersey shallot) send up seed stems and may make a few seeds, but the main energy of the plants goes into the production of numerous small bulbs at the base. The shallot is extensively used in England and on the Continent as a seasoning onion. Jersey shallots are most often sold in the United States under the name of "multipliers" and may be yellow or red in color.

VARIETIES OF ONIONS USED FOR SETS

Seed of almost any variety of onion may be used for the production of sets, but a greater demand exists for those of a distinctly yellow, white, or red color. In the trade the sets are recognized by their color rather than by actual varietal names. The demand for the yellow and the white sets is greater than that for the red, and those of the globular type are preferred. Onion sets are sometimes grown from left-over seed, in which case a large number of varieties may be included.

Southern-grown onion plants are now supplanting onion sets to a considerable degree, especially for starting early onions grown in home and market gardens. These plants, which are grown mainly in the Gulf Coast States and in southwestern Texas, are crated and shipped in great quantities to northern dealers and gardeners. There appears, however, to be little difference in the cost of the seedling plants as compared with sets, especially for small plantings.

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